



UGANDA PROTECTORATE.

---

ANNUAL REPORT  
OF THE  
DEPARTMENT OF  
AGRICULTURE

(PART II)

FOR THE

*Year ended 30th June, 1937.*

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PRICE : SHS. 4/50.

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Published by Command of His Excellency the Governor.

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ENTEBBE:

PRINTED BY THE GOVERNMENT PRINTER, UGANDA.

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## INTRODUCTION.

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Part II of the Annual Report gives an account of the activities of the staff of the Laboratories Division of the Department and is a record of the experimental work carried out by them and by officers of the Field Division during the crop year ending June 30th, 1937.

The team work of the officers stationed at the Serere Experiment Station continues to give satisfactory results and I can foreshadow a similar collaboration of technical officers at the new Kawanda Experiment Station now in course of construction. A new laboratory, in which provision is made for Botanical and Plant breeding work in addition to Entomological, Chemical and Mycological research, will be completed before another year has passed. The plant breeding at Bukalasa and all work formerly undertaken at Kampala will be transferred to Kawanda which is eight miles away. No new experiments have, therefore, been planted at Bukalasa or Kampala and the records of those stations, particularly in connection with coffee, are progress reports of existing experiments. Kawanda will eventually become the centre for our *Robusta* coffee work and selections both of local and Java origin have already been established there.

In cotton the work at the Serere Experiment Station, where the aim is the production of improved strains for the short grass dry climate area, has progressed, and particular attention is drawn to the spinning reports on some of the strains derived from U4. One of these is now being multiplied with a view to production on a commercial scale.

Observations on Jassid populations, though not yet complete, indicate that this pest may not be quite so important as at first imagined.

It is also encouraging to find indications of varietal resistance to both Jassid and Helopeltis.

This brings me to another subject of entomological and general interest to cotton producers—the cotton stainer. A full investigation of this insect and the damage caused by it has been carried out during the past year and the importance of control measures is pointed out. One of the most practical measures is that also advocated in the case of the Pink Bollworm, namely, the rigid enforcement of the close season for cotton growing and the curtailment of the period during which planting takes place. Powers have recently been taken by an amendment to the Cotton Ordinance giving the Director of Agriculture authority to prohibit planting after a specified date. Early planting is essential if a high yield is to be obtained. Late planting must in time be brought under control and the people educated to appreciate the reasons for these restrictive measures.

In the last Annual Report the failure, due to Wilt disease, of the most promising of the Bukalasa cottons was mentioned. It is satisfactory to read that another useful strain which appears to have the properties required for Buganda is approaching the multiplication stage.



In *Arabica* coffee the Bugusege experiments, which have been fully described in previous reports, continue to give useful information on the management of the crop. At the request of the Coffee Experiment Sub-committee of the Coffee Board new experiments have been laid down.

Some sections in this report are not as detailed as formerly but this is due to the fact that the officers concerned have been permitted to reduce their reports to summarised form in view of their contributions to the forthcoming comprehensive publication, entitled "Agriculture and Agricultural Research in Uganda".

A. S. RICHARDSON,  
*Acting Director of Agriculture.*

## REPORT OF THE SENIOR ENTOMOLOGIST FOR 1936.

### Locusts.

The infestation by *Nomadacris septemfasciata* continued on a small scale in the southern and western areas. Egg-laying, delayed apparently owing to cooler and wet conditions, occurred early in the year and the size of the resultant hopper-bands, which appeared in March, though still very small in some cases, was larger than those of the previous years. In populated areas the bands were killed or broken up by the people and only a small proportion of the hoppers reached the flying stage during June. Negligible damage was caused to crops by this generation.

The surviving Uganda-bred fliers were supplemented during June and July by immigrants from territories to the south. Some damage to food-crops, coffee and cotton occurred in Mubende and Toro Districts. Egg-laying commenced in October (earlier than in previous years) and was continued into November. The first hatchings were observed in the latter month. Hoppers were recorded in south-west Mubende, eastern Toro, Entebbe, and Masaka Districts. Action against the hoppers was taken by the local population in the vicinity of cultivation in most areas, ring-burning being employed with great success in the Masaka District. Some further damage to crops was caused by hoppers, eastern Toro being much the worst affected.

The usual monthly reports were compiled and distributed to surrounding territories and the Imperial Institute of Entomology. Maps, shewing distribution of locusts, were also prepared each month.

### Beekeeping.

The Laboratory Assistant toured northern Mengo District (January 1st to 19th) and gave demonstrations of wax extraction and preparation at various centres. He also prepared an exhibit and supervised similar demonstrations by the section's African Beekeeping Instructor at the Lira Welfare Exhibition.

The amount of wax purchased on behalf of Government during 1936 only amounted to 458 lbs. The results from Kigezi District, which was expected to furnish several tons, were most disappointing.

An African Instructor toured Gomba County of Mengo during March and April to demonstrate wax preparation, but very little interest was displayed by the people. The extension work, in connection with beekeeping, by Agricultural Officers at Bukalasa, Fort Portal, Masaka and Lira in their respective districts, is gratefully acknowledged.

### Conferences.

The writer attended the Medical Research Conference at Nairobi; the Trypanosomiasis Conference at Entebbe, and the Agricultural Research Conference at Amani.

### Advisory.

A considerable number of the usual requests for assistance in combating crop, household, decorative plant, and timber pests was dealt with. Eleven nuisances caused by bee swarms in buildings were attended to.

### Miscellaneous.

*Coffee-planting Experiment.*—It was possible to make only one series of individual tree observations. Twelve series of small crop pickings were weighed and recorded.

*Famine Food Storage.*—A cyclostyled leaflet was prepared on storage of various food-crops in relation to damage by insects, and this was circulated to all Administrative and Agricultural Officers for their guidance. In connection with the storage of Sorghum as a famine reserve preliminary experiments were carried out to determine the relation of moisture content to damage by grain moth and weevil; for further investigation of the subject seed of varieties reputedly resistant to insect attack in storage was obtained by the writer from the Tanganyika Department of Agriculture.

*Plant Importations.*—During the year, 196 packages of plants were inspected.

### Publications.

T. W. CHORLEY.—“Improvement in Native Bee-keeping in Uganda.”

H. HARGREAVES.—“Variegated Coffee Bug (*Antestia* spp.) in Uganda.”  
(both in the *East African Agricultural Journal*, Vol. 1 (1935-36).

H. HARGREAVES,  
*Senior Entomologist.*

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## REPORT ON INVESTIGATIONS OF COTTON STAINERS (*Dysdercus* spp.) for 1936.

By H. HARGREAVES and T. H. C. TAYLOR.

### I. Introduction.

The species of *Dysdercus* all appear primarily to be seed-feeders with a range of food plants restricted exclusively to the Tiliales and Malvales. They prefer ripe seed, either in the open fruit or on the ground, but feed also on unripe seed, piercing fruits to reach it. Their importance as pests is due mainly to their ability to introduce fungi and bacteria into the unripe bolls during feeding, thus causing internal boll-rots, which destroy the contents of the infected locs. The bugs have a special association with fungi of the genus *Nematospora* and a high proportion of the boll-rot infections caused by *Dysdercus* are of *N. gossypii*.

Four species of *Dysdercus*\* occur on cotton in Uganda: *nigrofasciatus*, Stal., *superstitiosus*, Sign., *fasciatus*, Sign., and *cardinalis*, Gerst.†. *D. nigrofasciatus*, is distributed throughout the cotton-growing areas and is usually the commonest species. *D. superstitiosus* is also widespread but appears to be more abundant in the drier areas of the North, including West Nile, and East. There are indications that its occurrence on cotton is more irregular than that of *nigrofasciatus*. The third species, *fasciatus*, is much more irregular in incidence than either of the foregoing, occurring occasionally in fair numbers in certain areas only, while in other seasons it may be rare or apparently absent; it seems probable that, unlike the two species mentioned above, *fasciatus* is a comparatively recent immigrant in Uganda, and has come from the drier areas to north and east, its spread having followed that of cotton cultivation. The only localities in which it has occurred in the 1936-37 season are Mukoko, near Masaka, and Kampala, as far as one can judge from extensive surveys in all districts. *D. cardinalis* appears to be confined to the drier areas (West Nile, Gulu, Lango, Teso and North Busoga), where it is often not uncommon at the end of the cotton season, though almost always less common than *nigrofasciatus* and *superstitiosus*. In a recent survey in Bunyoro, Gulu and West Nile Districts it was found in almost every cotton plot north of a line passing through Gulu Township and Rhino Camp, and it was entirely absent south of this line. In two localities in Gulu District it was the predominant species.

The *Dysdercus* problem in Uganda is complicated by the varied climate of different parts of the cotton-growing area (for convenience classed as wet or dry areas) which involves a considerable repetition of investigations because of the effect of climate, directly on the behaviour of the bugs and indirectly through the alternative host plants which form the reservoir for the initial infestation of cotton each season.

\* A key for distinguishing these in the field is given by G. L. R. Hancock in *Uganda Journal*, III, p. 31, 1935-36.

† Other species recorded from this country but not known to attack cotton are: *D. migratorius*, Dist., *D. pretiosus*, Dist., and *D. ugandanus*, Schout. Gowdey in Ann. Repts. erroneously recorded *pretiosus* (probably *fasciatus*) as a pest of cotton.

During recent years it has become increasingly evident that these admittedly serious pests have been held responsible for much more damage than they have actually caused. The tendency has been to ascribe the cause of *all* discoloured or second-quality cotton to the feeding of *Dysdercus*: rain-soiled lint, stained lint produced by blackarm or other bacterial infection of the boll, rots due primarily to attack by bollworms (especially *Argyroplote*), and the immature lint from bolls caused to open by the sudden advent of intensely hot and dry conditions, all being included. Prior to the present comprehensive enquiry (which is still in progress) the investigations of *Dysdercus* spp. were restricted almost entirely to field studies. These were of a general nature and included such aspects as seasonal prevalence and incidence on cotton and alternative hosts, the nature and extent of the damage, and the factors influencing its intensity.

Since no marked differences have been found during the investigations of the bionomics of the four species, a combined account will suffice for our present purpose. The current enquiries were commenced in the "close season" of 1936 when no boll food was available, and it was necessary, as well as convenient, to utilise cotton seed with an ample supply of water in the main investigation, thus ensuring uniform quality of food; the four species were kept in the laboratory under as nearly identical conditions as possible in order to obtain comparable results. It must be pointed out that the abundant supply of rich food obviated any necessity for the bugs to wander in search of food, and undoubtedly had the effect of diminishing appreciably the period of the life-cycle in comparison with that of bugs in the field. On the other hand, confinement in cages would tend to reduce fertility and longevity.

During the first two months of this enquiry considerable mortality of adult bugs and consequent difficulty in obtaining complete series of records, resulted from infection by disease, chiefly fungal. In addition, and throughout the period, deaths of females occurred prematurely as a result either of their being egg-bound or of what was tentatively attributed to acute constipation: instances of the former had fully developed eggs in numbers up to 112 present in the ovaries, while in "constipated" females few if any eggs were present and the abdomen was swollen to the size attained when a large batch of eggs is about to be laid. It is suggested that these anomalies resulted from the restriction of movement consequent on confinement, or possibly also from idiosyncrasies of individuals in relation to the restriction of food to damp cotton seed, although, since the "constipation" was observed only in females its explanation appears primarily to be connected with sex.

## II. Bionomics.

### (a) *Egg-laying.*

Oviposition was observed in the laboratory only, and always occurred during the daytime. When only cotton seeds were available for hiding the eggs, the female pushed the seeds apart by means of head and legs, making a hollow about  $\frac{1}{4}$  inch across and  $\frac{3}{8}$  inch deep, the excavation of which generally required half an hour. After a final inspection the bug perched on the edge of the cavity with its abdomen obliquely within it, and then proceeded to oviposit, taking  $1\frac{1}{2}$  hours to lay a full batch of 120 eggs. When the final egg was laid the bug looked into the cavity, felt the eggs with its antennae and commenced to pull and push seeds with its legs, arranging a complete cover over, but not touching, the eggs. The female then, and periodically while

piling more seeds over the eggs, inserted its antennae to determine whether a sufficient depth covered the eggs, and continued to move seeds (sometimes in the wrong direction) until three tiers of seed (about  $\frac{3}{4}$  inch) were piled over the egg cavity; at this depth the bug just failed to touch any eggs with the tips of its antennae. The operation of making the protective cover required over one hour.

In dry, granular soil the bug scooped a hollow  $\frac{1}{4}$  inch deep at the side of the glass container and, after laying, covered the eggs with soil fragments (which did not touch the eggs) to a depth of  $\frac{1}{2}$  inch, finally placing a single layer of cotton seed on top.

With damp, fine soil, eggs were again laid at the sides of the container which acted as a firm edge for the egg cavity; in one instance  $\frac{1}{4}$  inch of soil surmounted by broken dead leaves (supplied to see if they would be used) was employed to cover the eggs; in a second instance scarcely any soil was put over the eggs, the cover being formed chiefly of a thin layer of leaf fragments.

Under field conditions eggs are laid in the soil in sheltered places away from the food-plant, and are extremely well hidden. In the case of exposed cotton seed heaps, *Dysdercus* buries its eggs among the seed.

The average sizes of eggs for the various species are sufficiently constant to enable them to be identified in most cases.

#### (b) Viability of Eggs.

There was a slight tendency in some individuals for fertility of eggs to decrease with the age of the female, but this was by no means constant.

| Bug No. | % Viability of successive batches of eggs. |     |     |     |    |    |    |    |    |    | Mean | General Average.                                           |
|---------|--------------------------------------------|-----|-----|-----|----|----|----|----|----|----|------|------------------------------------------------------------|
| 17      | 100                                        | 97  | 96  | 92  | 52 | .. | .. | .. | .. | .. | 91   | Of 23 batches laid by 4 females; 1,362 of 1,551 eggs: 88%. |
| 19      | 90                                         | 78  | 72  | 61  | 55 | 59 | 33 | .. | .. | .. | 70   |                                                            |
| 21      | 97                                         | 95  | 94  | 100 | 99 | 95 | 93 | 90 | 94 | .. | 96   |                                                            |
| 22      | 93                                         | 61  | ..  | ..  | .. | .. | .. | .. | .. | .. | 84   |                                                            |
| 9       | 100                                        | 98  | 99  | 51  | 96 | 8  | .. | .. | .. | .. | 84   | Of 28 batches laid by 6 females; 1,123 of 1,733 eggs: 65%. |
| 10      | 99                                         | 68  | 8   | 0   | 0  | 0  | .. | .. | .. | .. | 34   |                                                            |
| 11      | 81                                         | 100 | 44  | 0   | 20 | 0  | .. | .. | .. | .. | 50   |                                                            |
| 12      | 28                                         | 100 | 84  | 86  | .. | .. | .. | .. | .. | .. | 66   |                                                            |
| 24      | 100                                        | 94  | 100 | ..  | .. | .. | .. | .. | .. | .. | 98   | Of 45 batches laid by 7 females; 3,665 of 4,500 eggs: 81%. |
| 25      | 48                                         | 100 | 100 | ..  | .. | .. | .. | .. | .. | .. | 78   |                                                            |
| 1       | 86                                         | 67  | 66  | 83  | 60 | 70 | .. | .. | .. | .. | 73   |                                                            |
| 2       | 95                                         | 94  | 85  | 69  | 61 | 85 | 67 | .. | .. | .. | 84   |                                                            |
| 3       | 47                                         | 97  | 51  | 84  | 81 | 74 | 77 | .. | .. | .. | 71   |                                                            |
| 4       | 99                                         | 99  | 98  | 97  | 97 | .. | .. | .. | .. | .. | 98   |                                                            |
| 5       | 62                                         | 71  | 66  | 92  | 79 | 67 | 76 | .. | .. | .. | 74   |                                                            |
| 6       | 100                                        | 97  | 96  | 97  | 97 | .. | .. | .. | .. | .. | 98   |                                                            |
| 7       | 100                                        | 88  | 48  | 62  | 61 | 79 | 84 | .. | .. | .. | 78   |                                                            |

NOTES.—Nos. 17 to 22, *fasciatus*: fed on cotton seed and water; one male to each female. All batches laid by No. 21 and last batches only of the others used in obtaining viability.

Nos. 9 to 12 and 24 and 25, *nigrofasciatus*: Nos. 9 to 12 fed cotton seed and water, No. 24 on roselle and later bamia, No. 25 fed bamia only. One male to each female. Fertility based on all eggs of No. 11, first batches of No. 25 and last batches of the others.

The low viability of the last batches of Nos. 10 and 11 markedly reduces the general average viability of the species; if these are excluded the average becomes 84%, comparable with those of the other two species, though it is admitted that the series of bugs on which the figures are based are small.



Nos. 1 to 7, *superstitiosus*: all batches laid included excepting last one of No. 3. One male per female for first 4 batches of No. 1, first six of No. 2, first three of No. 3, all of No. 4, first three of No. 5, first 5 of No. 7; all other batches from females with two males each.

It was thought possible that a low egg-viability might be attributed to the male concerned or to restriction of one male to each female. In order to test this an additional male each was put with a few females (*superstitiosus*) after they had laid several lots of eggs. With the additional male in three cases there was an increased proportion of fertile eggs from the same female compared with the viability during the previous period with one male, the percentage being 79 against 64, 80 : 66 and 85 : 76, the averages throughout life being 71, 74 and 78% respectively; in a fourth case there was a slight reduction of viability during the later period with two males (74 to 72, life average 73%). On the other hand a female with one male throughout life gave exactly the same average fertility of eggs (98%) as another female with two males during the same period.

#### (c) Incubation Period.

A marked effect of temperature on incubation was noticeable, the time occupied in the laboratory being increased by a whole day during the cooler period of the investigation, consequent on a general reduction of temperature from 80° to 75°F. Eggs of *superstitiosus* hatched after 7 days to 8 days, while in the cases of *nigrofasciatus* and *fasciatus* incubation required somewhat longer, 7 days 15 hours to 8 days 20 hours and 8 days to 8 days 22 hours respectively (exact minima and maxima).

The incubation period of *cardinalis* was found to be rather shorter than that of any of the others (5 days in hot weather and 7 days in cooler weather), but as the tests for *cardinalis* were not carried out at the same time as the others the figures may not be quite comparable.

#### (d) Nymphal Stages.

The first instar nymphs do not feed. They remain massed together in the soil, in the cavity in which the eggs were deposited. Moisture is the only requirement in this instar\* and provided the soil is sufficiently moist the first moult takes place *in situ* in the egg cavity, the nymphs scarcely moving at all until after the first moult. Having attained the second instar the nymphs make their way to the surface of the soil and disperse in search of food. Since the eggs are often laid at considerable distances from host plants the nymphs must often wander for a long time, probably several days in some cases, before finding food. The beginning of the second instar is to be regarded as the beginning of the feeding period, but if food is not available the nymphs can survive for many days, and even reach the third instar, with water as their only means of sustenance†.

The preferred food, of nymphs and adults alike, appears to be ripe seed. This applies not only to cotton, but also to the wild host-plants. Pearson‡, writing of stainers in S. Africa, states: "Whilst second instar nymphs have stylets long enough to penetrate the wall of bolls (of cotton) of any size, in actual fact the amount of feeding that takes place on unopened bolls is small" and "not until the fourth instar was reached did nymphs thrive satisfactorily upon unopened bolls". He concludes that nymphs younger than the fourth instar are not of any importance in the spread of internal boll disease. Actually it is probable that most of the damage is caused by last instar nymphs

\* v. (j) below.

† v. (k) below.

‡ Pearson, E. O., *Bull. Ent. Res.* XXV, pp. 383-414 (1934).

and adults. The results of feeding stainers on green bolls are further discussed in Section (I) below.

Stainers are markedly gregarious in all stages of their development, but particularly so during the early instars and when they are about to moult. Last-instar nymphs, and to a lesser extent younger nymphs, have the habit of wandering away from their host-plants when ready to moult and congregating in shady situations such as clumps of grass or the undersides of leaves of broad-leaved plants, where they remain until ecdysis is completed. This habit is especially noticeable in cotton plots during dry weather, when the condition of the plants is not such as to afford much shade. In such circumstances last-instar nymphs may wander considerable distances for the final moult, and groups of at least 50 individuals have been observed in situations separated from the cotton plots in which they must have fed by 18 feet of bare ground.

The rate of development varies greatly according to the condition of the food, the water supply and the species of host-plant. The rate on host-plants other than cotton is discussed in a later section. The most rapid and uniform development on cotton results when ripe seed is the source of food and an adequate and regular supply of water is available. Under these conditions the time required for development of the bug from hatching to the attainment of the adult form was almost the same for all four species, the actual figures obtained for large batches being:—

*Superstitiosus*, 30–35 days; *nigrofasciatus*, 31–33 days; *fasciatus*, 33–36 days; and *cardinalis* (in hotter weather) 26–31 days. The durations of the five nymphal instars proved to be 4–5, 5–6, 5–6, 6–8, and 9–13 days successively for all species except *cardinalis*, for which the corresponding figures (in hotter weather) were 3, 4, 5, 7–9, 7–10 days. Males always develop slightly more rapidly than females and become adult one or two days before any females of the same family group.

#### (e) Sex-ratio.

Series of adults bred in the laboratory indicate that the sexes are approximately equal, the numbers for the four species in alphabetical order being 40 to 46, 183 to 176, 63 to 79 and 91 to 97 males to females respectively.

The sex-ratios of dead bugs collected in the field under *Hibiscus* spp. and of wild adults which died in the laboratory during about six weeks of May and June in order of female to male were:—

|                       |    |    |           |             |
|-----------------------|----|----|-----------|-------------|
| <i>fasciatus</i>      | .. | .. | 41 : 79   | (1 : 1.93)  |
| <i>nigrofasciatus</i> |    | .. | 465 : 963 | (1 : 2.07)  |
| <i>superstitiosus</i> |    | .. | 51 : 105  | (1 : 2.06). |

Considering separately the *nigrofasciatus* collected alive and included in the above figures the high male ratio of 2.39 is shown (385 to 161 females).

Collections of adults of *nigrofasciatus* from wild host-plants within 20 miles of Kampala at the end of May, 1936, and in July, 1936, gave the following figures:—

|      |    |               |    |           |    |           |
|------|----|---------------|----|-----------|----|-----------|
| May  | .. | female : male | :: | 223 : 318 | :: | 1 : 1.46. |
| July | .. | female : male | :: | 92 : 107  | :: | 1 : 1.16. |

The reason for this marked preponderance of males in the field is obscure: if it were due to greater longevity of the male one would expect a much higher male ratio in *superstitiosus* as indicated by their longevity in the laboratory. It is possible that the high male ratio is indicative of the ability of this sex to fly longer distances than the female, the well-isolated group of *Hibiscus* plants acting as an attractant over a wide area. There were no marked or constant sexual differences in susceptibility to disease or parasites which might have accounted for the disparity of the sexes.

(f) *Pre-oviposition Period.*

While the minimum time to the laying of the first clutch of eggs was 6 days for *fasciatus*, *nigrofasciatus* and *superstitiosus*, the average periods (8 females each) were 8 days for *fasciatus* and 9 days for the other three species, with a common maximum of 11 days. The first copulation was observed sometimes only two, but usually three days after the female became adult. Pairing was noted almost every day and for long periods; it was continued at least until the laying of the final clutch and in many cases to the end of life.

(g) *Egg-capacity.*

With few exceptions the first clutch laid by each female was the largest; the highest numbers recorded for any clutch were 154 for *cardinalis*, 152 for *superstitiosus*, 136 for *nigrofasciatus* and 131 for *fasciatus*. The general tendency shown was a diminution in number of eggs of successive clutches but this, as will be seen from the Table below, was by no means constant. There is no apparent relation between the number of eggs in each batch and the number of ovarioles, of which in all four species there are seven to each of the two ovaries; during early maturity each ovariole was shown by dissection to contain seven eggs of graduated size. Occasionally batches of eggs contained a few of abnormally small size, these proving infertile.

The intervals between successive lots of eggs were rather variable and there was no correlation between the number of eggs laid and the interval preceding any laying. The following summary gives in days the minima and maxima, the average and the general period of the intervals between egg-laying for three species when fed on damp cotton seed:

|                          |                                        |
|--------------------------|----------------------------------------|
| <i>fasciatus</i> ..      | .. 4 to 7; 5; 30 of 48 being 5 days.   |
| <i>nigrofasciatus</i> .. | .. 4 to 8; 5.5; 26 of 48 being 5 days. |
| <i>superstitiosus</i> .. | .. 4 to 6; 4.9; 35 of 46 being 5 days. |

This shows that in the majority of instances a clutch of eggs was laid every 5 days.

The table indicates a wide variation in the duration of fertility for individual females of all species; in some instances this is accountable by disease or accident, but in others it is inexplicable except as individual limitations or as resulting from the confined conditions. Eliminating premature deaths the variations in total number of eggs laid by *fasciatus*, *nigrofasciatus* and *superstitiosus* respectively were:—

|                                                           |
|-----------------------------------------------------------|
| 750–876 (average 815 laid or 827 potential*, for 6 bugs). |
| 767–909 ( „ 850 „ or 874 „ †, for 4 bugs).                |
| 606–835 ( „ 718 „ or 750 „ †, for 4 bugs).                |

\* including eggs in ovaries at death.

† plus other very tiny eggs.



TABLE.

Fertility of *Dysdercus* (three species, fed cotton seed and water except No. 24).

| Bug No. | Numbers of Eggs in Successive Batches. |     |     |     |     |     |    |    |    |    | Total laid. | Eggs in Ovaries at death. | Fertility Period (days). |
|---------|----------------------------------------|-----|-----|-----|-----|-----|----|----|----|----|-------------|---------------------------|--------------------------|
| 16      | 131                                    | 129 | 114 | 108 | 106 | 109 | 83 | 44 | .. |    | 824         | 4                         | 33                       |
| 17      | 96                                     | 67  | 92  | 88  | 85  | 61  | 59 | 66 | 70 |    |             |                           |                          |
| 18      | ..                                     | ..  | ..  | ..  | ..  | ..  | .. | 62 | 40 |    | 786         | 17                        | 51                       |
| 19      | 110                                    | 101 | 86  | 76  | ..  | ..  | .. | .. | .. |    | 373         | 63                        | 17 (a)                   |
| 20      | 108                                    | 94  | 104 | 99  | 90  | 87  | 72 | 53 | 59 |    |             |                           |                          |
| 21      | ..                                     | ..  | ..  | ..  | ..  | ..  | .. | 47 | 34 | 18 | 868         | Nil                       | 66                       |
| 22      | 103                                    | 78  | 100 | 89  | 87  | 89  | 83 | 69 | 52 |    | 750         | 40                        | 39                       |
| 23      | 117                                    | 118 | 108 | 101 | 97  | 91  | 82 | 57 | 16 |    | 787         | Nil                       | 41                       |
| 9       | 130                                    | 127 | 108 | 104 | ..  | ..  | .. | .. | .. |    | 469         | 116                       | 14 (b)                   |
| 10      | 122                                    | 124 | 118 | 108 | 108 | 108 | 91 | 69 | 28 |    | 876         | 10                        | 46                       |
| 11      | 104                                    | 104 | 104 | 95  | 104 | 99  | 68 | 76 | 74 |    |             |                           |                          |
| 12      | ..                                     | ..  | ..  | ..  | ..  | ..  | .. | 57 | 24 |    | 909         | Nil                       | 54                       |
| 13      | 88                                     | 99  | 98  | 80  | 76  | 56  | 87 | 64 | 72 |    |             |                           |                          |
| 14      | ..                                     | ..  | ..  | ..  | ..  | ..  | .. | .. | 47 |    | 767         | 40*                       | 53                       |
| 15      | 53                                     | 93  | 55  | 72  | 40  | 26  | .. | .. | .. |    | 339         | 31                        | 32                       |
| 16      | 119                                    | 129 | 112 | 108 | 101 | 90  | 74 | 61 | 33 |    |             |                           |                          |
| 17      | ..                                     | ..  | ..  | ..  | ..  | ..  | .. | 38 | 29 |    | 894         | 54                        | 56                       |
| 18      | 113                                    | 109 | 128 | 113 | 108 | 94  | 88 | 77 | .. |    | 830         | 1                         | 26                       |
| 19      | 120                                    | 132 | 124 | 118 | 57  | ..  | .. | .. | .. |    | 551         | 112                       | 21 (b)                   |
| 20      | 106                                    | 118 | 61  | 88  | ..  | ..  | .. | .. | .. |    | 373         | 104                       | 17 (a)                   |
| 21      | 136                                    | 36  | 115 | 110 | 64  | 73  | .. | .. | .. |    | 534         | 5                         | 35 (e)                   |
| 22      | 152                                    | 120 | 113 | 99  | 76  | 70  | .. | .. | .. |    | 730         | 74                        | 31 (c)                   |
| 23      | 133                                    | 120 | 115 | 96  | 87  | 88  | 82 | 70 | 44 |    | 835         | 10*                       | 37 (e)                   |
| 24      | 124                                    | 96  | 83  | 75  | 73  | 76  | 69 | 60 | .. |    | 656         | Nil                       | 37 (d)                   |
| 1       | 125                                    | 98  | 92  | 100 | 78  | ..  | .. | .. | .. |    | 493         | Nil                       | 21                       |
| 2       | 128                                    | 116 | 102 | 103 | 98  | 87  | 79 | .. | .. |    | 713         | Nil                       | 31                       |
| 3       | 142                                    | 116 | 118 | 104 | 101 | ..  | .. | .. | .. |    | 581         | *                         | 21 (e)                   |
| 4       | 127                                    | 108 | 97  | 88  | 78  | 61  | 47 | .. | .. |    | 606         | 44                        | 29 (e)                   |
| 5       | 128                                    | 122 | 118 | 77  | 61  | 17  | .. | .. | .. |    | 523         | Nil                       | 26                       |

NOTES. —Nos. 16—23 *fasciatus*; Nos. 9—15 and 24 *nigrofasciatus* (24 fed on *Hibiscus esculentus* fruit); Nos. 1—8 *superstitiosus*.

Premature deaths:—

- (a) fungal disease;
- (b) egg-bound;
- (c) accident (lost four legs);
- (d) ? bacterial disease;
- (e) constipation.

\* Other tiny eggs, No. 6 with many.

#### (h) Longevity of Adult.

A considerable proportion of both sexes and all species was killed by disease when 4 to 5 weeks old. Without including these, the mean lengths of adult life in days under laboratory conditions were: *fasciatus*—female 62 (min. 40, max. 83), male 65 (55–80); *nigrofasciatus*—female 62 (49–71), male 71 (58–84); *superstitiosus*—female 43 (37–47), male 91 (57–148).

Individuals which were given no opportunity to pair normally yielded higher maximum figures, except in the case of the male of *superstitiosus*. The maxima for these in days were: *fasciatus*—female 99, male 115; *nigrofasciatus*—female 126, male 139; *superstitiosus*—female 68, male 128.

#### (i) Inter-specific Pairing.

When two or more species of *Dysdercus* are present on the same plant cross-pairing may be observed not infrequently, particularly when the male of

one species is much more numerous than the female of its own kind and also predominates over either sex of any other species. This, together with the fact that abnormal specimens which may be thought to be hybrids occur frequently, led to tests designed to ascertain whether cross-paired females could produce fertile eggs and whether the species were valid. All of the six possible crosses of the three common species (*fasciatus*, *nigrofasciatus* and *superstitiosus*) were tried in the laboratory, and copulation was observed in every case. The adults used had been reared from nymphs and were not known to have paired previously, and all the pairs were kept supplied with food and water until they died. Many of the females oviposited normally, both as regards number of eggs laid and frequency of laying, but all the eggs proved infertile. The conclusions drawn were that the species are valid and hybrids never occur, and that although eggs laid by females found cross-pairing in the field are often fertile their fertility is attributable to previous copulation with males of their own kind.

(j) *Influence of Humidity on Eggs and First-Instar Nymphs.*

Experiments have been conducted to ascertain to what extent humidity is concerned in the hatching of eggs and in the survival of the young nymphs in the soil. The eggs, and later the resulting young nymphs, were enclosed in sealed jars over aqueous solutions of potassium hydroxide of strengths such that humidities of 30, 40, 50, 60, 70, 75, 80 and 90% were obtained\*. A newly-laid batch of 200 eggs of each of three species of *Dysdercus* was placed in each jar. The temperature was not controlled, the jars being kept on a bench in the laboratory. Batches of eggs of each species, placed in open tubes near the jars, were used as controls. The results may be summarised as follows:—

1. All the eggs developed normally, regardless of humidity, except for a certain number in each batch which, as is usual, proved infertile. The percentage which did not develop was the same in all the batches in the jars as in the controls.

2. At 30% humidity none of the eggs hatched, although the nymphs developed normally within them. Presumably the nymphs were simply unable to break the chorion.

3. At higher humidities the results obtained were as in the following table, in which the figures are the percentage of fertile eggs which hatched:—

| Humidity.                   | 40% | 50% | 60% | 70% | 75% | 80% | 90% |
|-----------------------------|-----|-----|-----|-----|-----|-----|-----|
| <i>D. superstitiosus</i> .. | Nil | 10  | 27  | 52  | 57  | 57  | 55  |
| <i>D. fasciatus</i> ..      | 6   | 47  | 49  | 68  | 63  | 67  | 69  |
| <i>D. nigrofasciatus</i> .. | 5   | 42  | 56  | 63  | 62  | 63  | 65  |

From this table it is clear that the results for the last two species were very similar and that the eggs of both can survive lower humidities than those of *D. superstitiosus*. It is also evident that the minimum humidity required for the maximum percentage hatching is 70%.

\* In making up these solutions allowance must be made for the amount of water in the KOH sticks. This is a very necessary precaution.

4. After the eggs had hatched the resulting nymphs were left in the jars. It was found that, at 50% humidity, all the nymphs of *D. supersticiosus* and *D. nigrofasciatus* died in the first instar, but a few of those of *D. fasciatus* reached the second instar; at 70% humidity several nymphs of *D. supersticiosus* and *D. nigrofasciatus* reached the second instar and very many of those of *D. fasciatus* reached the second instar; and at 75% humidity and upwards all the nymphs of all the species flourished and reached the second instar. Thus it appears that the nymphs of *D. fasciatus* can survive lower humidities than those of the other two species.

5. It is important to notice that whereas in the case of the eggs, *D. supersticiosus* is the least resistant to the lower humidities, both *D. supersticiosus* and *D. nigrofasciatus* were, in the case of nymphs, less resistant than *D. fasciatus*. Therefore, considering the results for eggs and nymphs together, we conclude that *D. fasciatus* can survive low humidity more readily than either of the other two species; and this agrees with field observations elsewhere, particularly in the Sudan where *D. fasciatus* is the only species present in the driest of the districts in which stainers occur.

6. It was found in the jars that the rate of development of nymphs in the first instar increased with the humidity. The shortest duration of the first instar was in the 90% jar, and this was uniform for all three species.

#### (k) Water Requirements of Older Nymphs and Adults.

The rate of development of *Dysdercus*, and indeed the actual ability to develop and reproduce, depends to a remarkable extent upon the availability of water. All stages show high resistance to absence of food in the presence of water, and negligible resistance to absence of water in the presence of food. Neither nymphs nor adults can obtain all the moisture they need from ripe seeds of any known food-plant: they require to supplement the supply in seeds extensively by sucking immature fruits or other parts of plants with a high water content, or by utilising raindrops, dew, or moisture in the soil. The normal food appears to consist of ripe seeds, but unless rain or dew falls regularly, the stainers attack unripe fruits (bolls in the case of cotton) also, and commonly. Rapid and uniform development in any batch of nymphs only occurs when ample water is provided daily, as well as ample ripe seed. A smaller or less regular water supply results in slow and irregular development or death, according to the amount of water available and the frequency with which it becomes available. In all laboratory tests with seeds of alternative host-plants it is necessary to maintain a constant supply of water in the containers, otherwise the results of different tests are not trustworthy or reliable. The frequent abundance of stainers in very hot, dry districts is misleading, because it suggests, erroneously, that these conditions are suitable for them. They are common in these circumstances only if cotton or alternative food-plants have many succulent, immature fruits still on them, in addition to ripe seeds, and if they were already common (as eggs and young nymphs) before the very dry weather set in. Hot, dry weather is fatal to eggs and first instar nymphs, and therefore renders breeding impossible, but a very large population can mature when once these earliest stages are past.

The great importance of humidity as a factor in the hatching of eggs and the development of newly-hatched nymphs in the soil has already been emphasised. After the first moult the nymphs climb the stems of plants, and they are then dependent for moisture on rain, dew, or the juices of the



plants themselves. Experiments have shown that second instar nymphs die within a week, and often within three days, if provided only with ordinary "dry" cotton seed in the condition in which it is ordinarily stored in bulk. Although this seed is not actually very dry, they make no attempt to feed, and they need water in quantity before they will do so. On the other hand, if nymphs of this stage are given no food whatever, but are constantly provided with plenty of water, they live for a long time (maximum 13 days after the first moult in the case of *D. supersticiosus* and 18 days in the case of *D. nigrofasciatus*) and many of them undergo a second moult, dying in the third instar. These young nymphs, and probably stainers of all ages except the first instar, can obtain a certain amount of food, as well as moisture (judging from the duration of life in such circumstances) from the recently-dead bodies of their companions or of other insects; to avoid this complication in the experiments summarised above in which water only was provided, the nymphs were removed from the containers when they showed signs of dying.

If the bodies are not removed and unhatched eggs of the same batch are left in the container, water being provided, the nymphs live longer and develop further. *D. fasciatus* lived 30 days (maximum) after the first moult and 5 individuals out of a batch of about 60 actually reached the fourth instar. In similar circumstances the maximum duration of life of *D. nigrofasciatus* after the first moult was 34 days and in this case also a few individuals reached the fourth instar. In no circumstances, however, can individuals mature without being provided with suitable plant food sooner or later; but all individuals such as those referred to above, which reached the fourth instar with dead bodies and unhatched eggs as their only food, can mature and produce normal adults if given suitable seeds just before they are likely to die in the fourth instar.

The nymphs, therefore, are remarkably resistant to adverse food conditions, provided only that ample water is available. There is, however, considerable evidence to indicate that nymphs of *D. supersticiosus* cannot live quite so long as the other two species on water only or on water and dead bodies, and are, in general, rather less resistant to adverse food conditions.

The adults live a very long time when given water only, provided they have fed on suitable seed for a few days before being deprived of food. Adults of *D. supersticiosus* lived 33 days (maximum for both male and female) when kept in separate tubes with water only, after having been fed for 8 days on cotton seed. With neither water nor food the adults die within 3 days. In dry weather adults are commonly to be seen apparently feeding on the flowers of a great variety of plants, other than true host-plants, but it is practically certain that they obtain little, if any, food from them and are actually utilising the flowers as sources of moisture.

The significance in the field of these facts is that stainers can survive conditions so adverse as to be fatal to many other insects. Only long periods of drought are fatal to them in bulk. The nymphs can wander long distances for many days in search of food, if they can get water, and can develop, although slowly, even if their food supply is very irregular. The adults can survive periods of at least a month, and probably much more, when their host-plants temporarily cease fruiting, by extracting moisture from other plants. Drought undoubtedly causes breeding almost to cease, because neither the eggs nor the first instar nymphs have sufficient moisture, except perhaps in or near swamps, and it also causes a very great reduction in the total population

and a wide dispersal in search of food and water; but in times of drought the ability of stainers to extract moisture, on account of their method of feeding and long proboscis, from sources not available to many other insects, compensates to a considerable extent for their marked dependence on water. A small percentage of individuals will survive a drought of normal seasonal duration even though breeding may be impossible.

(1) *Immature Cotton Bolls as Food for Dysdercus spp.*

Two experiments were conducted at Kampala to ascertain to what extent the rate of development, fecundity, and longevity of *Dysdercus* spp. are affected by the provision of green bolls for food. In both experiments, the bolls employed varied considerably in size, but in general they may be classed as half-grown; and every second day the bolls were removed from the cages and new ones were provided.

In the first experiment, designed to ascertain whether the insects could mature if fed on green bolls and water only throughout their development, and if so, at what rate, a normal batch of nymphs (about 70) of *D. supersticiosus* was used. These fed, as usual, on water only during the first instar. From the first moult onwards they were given green bolls and a constant supply of water. Many nymphs reached the third instar successfully and some reached the fourth, but since earlier experiments had shown that development to the fourth instar can occasionally take place when water only is provided, this was to be expected. Five individuals, however, reached the fifth instar, and this never occurs when water only is available. Eventually three became adult, almost all the others having died in the third and fourth instars. Development was exceedingly slow. The eggs hatched on the 19th January and the adults emerged on the 22nd March (one) and the 6th April (two); the period from hatching to the final moult was therefore 62 to 77 days, and this contrasts strikingly with the corresponding period (30 to 35 days) for nymphs fed on cotton seed in otherwise similar conditions.

The second experiment was designed to discover to what extent adults fed on immature bolls and water only from the fourth moult can oviposit and how long they can live. Ten females and twenty males of *D. nigrofasciatus* were used, one female and two males being put in each of ten identical cages as soon as the final moult was completed\*. Controls, fed on cotton seed and water only, were kept in similar cages. The results were convincing, and may be summarised as follows:—

- i. The preoviposition period was unusually long in every case. The mean for those fed on green bolls was 15 days and for the controls 8 days.
- ii. The total number of eggs laid by the females given green bolls averaged 282 (maximum 401), while the average figure for the species, when fed on cotton seed (*see* Section II (g)), is 850, and the controls approximated to this figure.
- iii. The average number of batches of eggs laid was 4.2; and the maximum was 5; females fed on cotton seed usually lay at least 6 batches (maximum 9), and the mean for the controls was 6.5.

\* The individuals employed were collected in the field as fourth instar nymphs in a plot containing many mature bolls, and from observations made in the plot it is certain that their food had consisted very largely of ripe seeds.

iv. Oviposition took place very irregularly and the number of days between successive batches varied from 4 to 20, averaging 11. Females fed on cotton seed oviposit very regularly, usually every 5 days, and for the controls the mean was 5.

v. The adult life of the females fed on green bolls was not abnormally short (51 to 73 days), and the number of eggs per batch was not particularly low, the means for the first 3 batches being 107, 89, and 69. The low egg capacity is therefore mainly attributable to the small number of batches laid.

(The individuals used in this experiment had fed as nymphs principally on cotton seed. There is no doubt that if they had fed almost throughout their development on green bolls their reproductive capacity would have been even lower, probably very much lower).

From these experiments we may conclude that although immature bolls can serve as food, the percentage of *Dysdercus* which become adult when thus fed is exceedingly small, and the rates of development and reproduction are very slow. The practical significance of these experiments is that they support field observations in showing that *Dysdercus* cannot begin to multiply appreciably, until the cotton plants begin to bear ripe bolls. The duration of the breeding season for *Dysdercus* is therefore much shorter than that of the cotton season.

### III. Alternative Host-plants.

The species of *Dysdercus* under review have a number of host-plants in Uganda in addition to cotton which, mainly on account of intensive cultivation, is their principal source of food. The known host-plants in Uganda all belong to the closely allied families Malvaceae, Bombacaceae and Sterculiaceae. The term "host-plant" is here restricted to those plants on which breeding occurs. There are many other plants on the flowers and fruits of which adult stainers are occasionally to be seen, apparently feeding; but it is probable that the insects merely extract moisture from these plants, and it is certain that they cannot breed on them\*.

A survey of the host-plants of *D. nigrofasciatus*, *D. superstitiosus* and *D. fasciatus* and, to a lesser extent, *D. cardinalis*, has been conducted, and although much work still remains to be done, the most important aspects of the problem are fairly well understood. Field observations have been accompanied by numerous laboratory tests with the ripe seed of a variety of plants as food throughout the development of the insects. In all tests ample water was constantly provided. Records were kept of the duration of the instars and of the dates when the first and last individuals of each batch became adult. The rate and degree of uniformity of development, and the sizes of the resulting adults are reliable indications of the suitability of the different kinds of seed as food, and of the comparative preferences for the various plants tested, judging from supplementary field observations; and by combining the laboratory and field results it has been possible to draw up, for *D. nigrofasciatus*, the following list of host-plants, in which the plants are arranged in the order in which they are preferred:—

Cotton, *Ceiba pentandra*, *Hibiscus diversifolius*, *H. macranthus*, *Wissadula rostrata*, *Hibiscus ludwigii*, *H. micranthus*, *H. calycinus*, *H. gossypinus*, *H. esculentus*, *H. surratensis*, *H. rostellatus*, *H. cannabinus*, *H. asper*, *H.*

\* The plants in this category belong to widely separated families such as *Tiliaceae*, *Compositae*, *Bixaceae* and *Verbenaceae*.



*jatrophaefolius*, *Abutilon angulatum*, *A. indicum*, *Sida urens*, *S. schimperiana*, *Hibiscus panduriformis*, *Urena lobata*, *Pavonia schimperiana*, *Dombeya emarginata*.

All of these are known to be host-plants of *D. nigrofasciatus* in the field.

When the food, in laboratory tests, consisted of cotton seed, the period of development from the first moult to the last varied, in the case of *D. nigrofasciatus*, from 27 to 29 days, and the adults were all large; and when the food consisted of seeds of *Dombeya emarginata* the period varied from 37 to 62 days and the adults were small.

Many other plants, some of which were formerly suspected of being host-plants, have been examined in the field and tested in the laboratory and proved not to be true host-plants of any of the common species of *Dysdercus*. These include *Melhanian ferruginea* (Sterculiaceae); *Sida rhombifolia*, *S. cordifolia* and *Pavonia kraussiana* (Malvaceae); *Corchorus* spp. and *Triumfetta* spp. (Tiliaceae); *Lantana* spp. (Verbenaceae); many species of Leguminosae; *Amaranthus* sp. (Amarantaceae); *Bixa* sp. (Bixaceae); *Phoenix reclinata* (Palmae); and several species of Compositae. Some of these plants (*Pavonia kraussiana*, *Triumfetta* spp. and *Melhanian ferruginea*) are of special interest in that they can serve to some extent as food for nymphs; that is to say, stainers can reach the last nymphal instar (the fifth) when fed on seeds of these plants only, but invariably die without undergoing the final moult, and are undersized\*. The other plants in the same list cannot serve as host-plants at all and nymphs fed on their seeds live no longer than nymphs which are given water only.

The host-plants of *Dysdercus* spp. in Uganda are restricted almost entirely to the Malvaceae, the only known exceptions in Uganda being *Ceiba*, *Sterculia* and *Dombeya*†. Within the Malvaceae the preferred genera are *Hibiscus* and *Wissadula*, and it appears that all of the 26 spp. of *Hibiscus* in Uganda are true host-plants, although not all have actually been tested. The species with cottony seeds and small fruits are attacked to about the same extent as those with smooth seeds and large fruits. The only species of *Hibiscus*, which, although suitable as food, has proved to be appreciably less suitable than all the others tested, is *H. panduriformis*, the seeds of which are exceptional in being covered with a dense pile. The genera *Sida* and *Pavonia* differ from *Hibiscus* in that only certain of their species are attacked. The very common weeds *S. rhombifolia* and *S. cordifolia* are not attacked at all in the field or in the laboratory, although *S. urens* and *S. schimperiana* (which, however, have seeds of a different type) serve very well as host-plants. Similarly, stainers can mature (although slowly) on *Pavonia schimperiana* but not on the much more common *P. kraussiana*.

In the dry districts the most important alternative host-plants of the genus as a whole are *Wissadula rostrata*, *Hibiscus micranthus*, *H. calycinus*, *H. asper* and *H. cannabinus*, on account of their wide distribution and frequent occurrence.

In the wetter districts the most important species, for the same reasons, are *H. diversifolius*, *H. macranthus* and *Abutilon indicum*. The relative

\* A single individual of a batch of *D. nigrofasciatus*, which fed on seed of *Melhanian ferruginea* only, matured but was very undersized.

† Stainers have been recorded as breeding on *Sorghum* but, although there seems no doubt that both adults and nymphs can feed to some extent on it, it is very doubtful whether this is a true host-plant.

importance of the various plant species clearly depends as much on their abundance as on their suitability as food, and to this extent the list showing the order of preference is misleading, and the order of preference is not quite the same as the order of importance.

*D. supersticiosus*, *D. cardinalis* and *D. fasciatus* are, as a rule, much less frequently seen than *D. nigrofasciatus* and their occurrence is more sporadic and local. This suggests that these species are much more restricted in their choice of alternative host-plants than *D. nigrofasciatus*. In the laboratory, however, *D. supersticiosus*, *D. cardinalis* and *D. fasciatus* have proved to be able to feed throughout their development, and to mature satisfactorily, on precisely the same plants as *D. nigrofasciatus*; and if the plants are listed in the order of suitability as food, judging from laboratory observations, the order is almost identical, in both cases, with that already given for *D. nigrofasciatus*. There seems no doubt that the plants which serve as food for one species can serve for all four. It is known, however, that *D. supersticiosus*, *D. cardinalis* and *D. fasciatus* are not attracted in the field to so great a variety of plants as *D. nigrofasciatus*, although all four can develop on the same plants if actually confined upon them. Moreover, while *D. supersticiosus* and *D. nigrofasciatus* develop almost equally rapidly and satisfactorily on all the plants tested, *D. fasciatus* and *D. cardinalis* develop very much less uniformly and considerably more slowly on certain of the plants tested than do the other two species. Laboratory experiments indicate that, while the seeds of cotton and *Ceiba* are the most suitable in Uganda for all species (all four developing at the same rate on both), *D. nigrofasciatus* and *D. supersticiosus* find many other plants almost equally suitable, but *D. fasciatus* and *D. cardinalis* find very few others equally suitable. The difference, however, is merely one of degree. Another indication of the existence of slight differences in food preferences is that whereas *D. nigrofasciatus* and *D. fasciatus* are abundant on massed cotton seed on the ground near ginneries and cotton stores, *D. supersticiosus* is rarely seen in such situations although cotton seed is an ideal food for it and is at times severely attacked on the plants. Further, *D. fasciatus* shows a strong preference in the field for massed cotton seed on the ground and for those few host-plants which produce large seeds in quantity, notably cotton, kapok and *H. esculentus*, and it is always very rare on all other plants although in the laboratory it proves capable of maturing on as great a variety of plants as *D. nigrofasciatus*. *D. supersticiosus* on the other hand, appears normally to avoid massed cotton on the ground, and prefers living plants, and *D. nigrofasciatus* attacks massed seed and living plants equally.

In the drier districts, the environments of the various host-plants appear to determine to a large extent which species of *Dysdercus* attacks them. *D. supersticiosus* occurs mainly on species living in exposed situations (*H. asper* and *H. micranthus*) while *D. nigrofasciatus*, although common on exposed plants appears to prefer species which grow in shaded, sheltered situations (*H. calycinus* and *W. rostrata*). The preferred host-plants of *supersticiosus* in dry districts are mostly annuals which bear fruit for short periods only, while those of *nigrofasciatus* are in fruit for much longer periods. *H. calycinus* is perennial, and *W. rostrata*, although an annual, is very frequently found in partial shade, where its fruiting period is longer than in exposed situations. *D. supersticiosus* is therefore compelled to move at frequent intervals as its host-plants dry up, while *nigrofasciatus* can enjoy a more settled existence

and breed more continuously. This probably explains why in the drier areas *D. supersticiosus* is sometimes the more common species on cotton early in the season, although *D. nigrofasciatus* forms a large majority of the stainer population on wild host-plants and becomes predominant on cotton later in the season. In the wetter, cooler districts, these differences between the two species are much less apparent; *D. nigrofasciatus* cannot here be said to prefer shaded situations and *D. supersticiosus* is at no time predominant on cotton or any other species, except perhaps in isolated localities or on isolated individual plants.

*D. nigrofasciatus* is the predominant species in most parts of Uganda because it attacks a greater variety of alternative host-plants and frequents a greater variety of situations than any of the other species. At the end of the 1936-37 cotton season, however, *supersticiosus* was more common than *nigrofasciatus* throughout West Nile and the northern part of Gulu, and there are reasons for believing that this is normally the case in that area. It was noticed that the line running east and west through Gulu Township was the southern limit, in that part of the country, not only of the distribution of *D. cardinalis* and of the tree *Sterculia cinerea*\* which appears to be the principal wild host of *D. cardinalis*, but also of the area in which *supersticiosus* predominated over *nigrofasciatus*. *D. supersticiosus* breeds on *S. cinerea* abundantly and *D. nigrofasciatus* has very rarely been found on *S. cinerea*. It seems likely therefore, that this tree is responsible, to a large extent, for both the predominance of *supersticiosus* and the common occurrence of *cardinalis* in that area. In the same area, kapok is commonly grown, and all three of these *Dysdercus* spp. breed on it but it does not fruit at the same time as *Sterculia cinerea*. Consequently *D. supersticiosus*, which breeds on both, has more scope for multiplication than *D. nigrofasciatus* which apparently does not normally frequent *S. cinerea*. In Gulu and West Nile, herbaceous Malvaceae are uncommon, and *Dysdercus* spp. therefore depend, to an extent not equalled in other parts of Uganda, upon arboreal hosts. *D. supersticiosus* is, in any case, mainly an insect of the drier areas. It is present in all the wetter areas, but is usually uncommon and often rare and local. Even in the drier areas, with the possible exception of Gulu and West Nile, its occurrence is more irregular and seasonal than that of *nigrofasciatus*. These two species have a similar potential range of host-plants, but *supersticiosus* does not frequent so great a variety of situations and therefore does not utilise all of its potential herbaceous food-plants.

*D. cardinalis*, which is confined to the drier areas, and is almost invariably less common on cotton than *nigrofasciatus* and *supersticiosus*, evidently has a much more restricted range of host-plants and is probably to a large extent arboreal. In the laboratory it breeds successfully on *Abutilon* and many species of *Hibiscus*, but its rate of development on these plants is much slower than that of *supersticiosus* or *nigrofasciatus*, and is also much slower than its own rate (or that of any other species) on cotton, kapok or *Sterculia*.

*D. fasciatus* is mainly an arboreal species in its natural habitat. It flourishes in areas where trees such as *Sterculia* spp. *Thespesia* spp., and *Adansonia* (baobab) abound and provide, with or without cotton, a constant food supply

\* *Sterculia cinerea* is not uncommon in the north of Gulu and parts of West Nile. It also occurs at the top of the Butiaba escarpment and as a rarity in Teso. In all other areas, including south Gulu and the greater part of Bunyoro, it is entirely absent so far as we know at present.



throughout the year. No such areas exist in Uganda. It is not surprising, therefore, to find that *D. fasciatus* is normally a very rare species in Uganda. Occasionally it establishes itself and multiplies greatly in one or two isolated localities, breeding almost entirely on cotton and particularly on cotton seed dumps near ginneries and stores, but in most parts of Uganda it is entirely absent at any one time. The climate in the wetter parts of Uganda is ideally suited for the rapid breeding of this species, which, although relatively resistant to drought, requires high humidity for breeding; and its rarity in the Protectorate as a whole is solely attributable to the absence in most districts of its arboreal hosts.

The study so far made has shown very clearly that it is necessary to distinguish between the plants which can serve as food in the laboratory and those which actually serve as food in the field. In the case of *Dysdercus*, some species obviously are not attracted in the field to certain plants which could provide them with very suitable food. *D. ugandanus*, a species which has been bred very successfully on cotton seed in the laboratory, never attacks cotton in the field and appears to be almost entirely restricted to *Sida urens*. *Odontopus sexpunctatus*, an insect related to *Dysdercus*, very rarely attacks cotton and appears to be associated mainly with *Sterculia cinerea* but it breeds readily on cotton seed in the laboratory. The species of *Dysdercus*, while differing only slightly in their food preferences in laboratory conditions, differ greatly in distribution, degree of abundance, and economic status, and these differences are mainly due to choice of host-plants in the field.

#### IV. Natural Control.

##### (a) *Bogosiella fasciata*, Fabr. (Tachinid).

*Life-history*.—Females of this species caught in the field oviposit very readily in small cages containing stainers of suitable size. In the field and in the laboratory the eggs are laid singly upon the bodies or legs of the stainer adults and nymphs. Adults are preferred, but nymphs are very commonly attacked when they are more numerous than adults. The most usual positions for the eggs are the sides of the abdomen and the legs; much less frequently they are laid on the eyes, head, thorax and ventral surface of the abdomen, and very rarely on the under side of the hemielytra. The eggs are greyish white, smooth, opaque, broadly oval in outline when viewed dorso-ventrally and extremely tough. The surface of attachment is flat and the exposed surface is convex, but there is a slight median concavity and one end is considerably thicker than the other. They adhere very firmly to the integument of the host, and are conspicuous on account of their light colour and comparatively large size. The egg-shells remain attached to the hosts indefinitely after hatching, and on this account, and because the young larvae almost invariably succeed in parasitising the hosts, external examination of stainers affords satisfactory evidence of the presence or absence of this parasite within them, except that those stainers which are attacked as nymphs cast their skins subsequently and at the same time lose the egg-shells.

The parasite larva, on hatching, bores straight through that part of the egg-shell which is attached to the host and through the host integument in one operation. There is consequently no external indication of hatching. The activities of the parasite within the host have not been investigated, but it is known that larvae from eggs laid on the legs succeed in passing down

the legs and reaching the body and that parasitism is effected as frequently from eggs laid on the legs as from those on the body.

Normally only one parasite matures in each host, but occasionally two succeed in maturing. Very frequently many eggs are laid on one host by successive attacks of one fly or several flies, involving considerable wastage of eggs. The maximum number of eggs per host individual so far found in the field is 15 on one adult *D. nigrofastiatus*.

The initial attack of the adult parasite upon the host when the egg is laid has no effect upon the host, and the presence of the parasite larva within the host appears in no way to affect the activities of the latter, except oviposition, until the parasite is almost fully grown, when the host shows signs of weakness and lethargy. If the host is an adult female it usually lays one normal batch of eggs after it is attacked by the parasite but subsequently it oviposits very little and soon entirely ceases to do so, although apparently normal copulation and feeding continue. The parasite feeds mainly, if not entirely, upon the tissues of the abdomen, which it eventually nearly empties, particularly anteriorly. When fully fed, the parasite larva leaves the host through the anal opening, presumably rupturing the tissues for the purpose as it feeds within the body-cavity and not in the gut. The host does not die until some time (occasionally as long as 3 days) after the parasite larva has left it.

According to laboratory observations the parasite, on emergence from the host, drops to the ground and immediately burrows in the soil and proceeds to form the puparium; considerable moisture is necessary for the successful development of the adult in the puparium and this suggests that this parasite, like its hosts, can multiply only in wet weather.

There is marked sexual dimorphism in the adult, and the sexes may easily be distinguished in the field by the following characters:—

Female: Collar silvery grey, with a wide interruption mid-dorsally; face and genae similarly coloured; distal quarter of wings dusky.

Male: Collar, face and genae, golden-brown; collar continuous; wings dusky along costal margin, the dusky band widening distally, but no marked distal dusky area as in the female.

The adults of both sexes are frequently to be seen flying slowly around the host-plants of *Dysdercus*. They oviposit in a leisurely manner, first settling upon the stainers, most frequently selecting a copulating pair. The percentage of female stainers attacked is usually slightly larger than that of males, presumably only because the females are larger, and when copulating or full of eggs, are rather more lethargic. The egg-capacity is not known.

The life-cycle, as observed in the laboratory at Kampala in June, 1936, with adult stainers as hosts, is as follows: incubation, 3 days; larva, 13–16 days; pupa, 13–17 days (usually 13 or 14); total period from oviposition to emergence of adult 30–34 days (mean 32). When the hosts are attacked as young nymphs the parasite larvae develop much more slowly. The second instar is the earliest stage in which stainers are attacked. Nymphs attacked in the second or third instars attain the fifth instar before they are killed by the parasites, but never become adult. The life-cycle of the parasite (from the laying of an egg to emergence of the adult fly) is extended to 42 days when parasitism commences in the second instar of the host.

*Distribution.*—This parasite has been found commonly in all localities in the wetter parts of Uganda in which collections of stainers have been made,

and it is certainly very uniformly distributed in these areas. It is present in the drier districts also (Teso, Gulu, West Nile, Buruli and Busoga), although much less commonly, and there can be little doubt that it is generally distributed throughout the Protectorate.

*Hosts.*—*Dysdercus nigrofasciatus*, *D. superstilosus*, *D. fasciatus* and *D. ugandanus*. Probably all species of *Dysdercus* are attacked. It seems likely that the hosts are confined to the genus *Dysdercus*, as several other species of Pyrrhocoridae have been examined for eggs of the parasite with negative results. Pentatomidae have also been examined. The numbers of other species of bugs collected for this purpose, however, have been small and it is not yet possible to form any definite conclusions regarding the host-range of the parasite.

*Economic Value.*—Knowledge of the economic value of this parasite is, at the time of writing, in a rudimentary condition. After the cotton of the 1935-36 season had been uprooted the parasite was found to be abundant, relative to *Dysdercus*, throughout Mengo District. All the stainers then collected were from hosts other than cotton, and mainly from wild plants, and it is at present impossible to say definitely whether similar heavy parasitism ever occurs on cotton. Further study will be necessary to determine this point and also whether the high degree of control observed in the 1936 "dead season" is typical. The evidence at present available indicates that the parasitism on cotton is low even at the end of the season, and that the parasite frequents the wild host-plants much more than cotton. It also indicates that the parasite is much less effective in the dry areas than in the wet, and this is to be expected from the observed fact that moist soil is necessary for the emergence of the adult parasite from the puparium.

When the cotton is destroyed at the end of the season the stainers are driven to alternative food-plants, and if a high percentage parasitism can be attained on the latter then the parasite is clearly of great importance as a means of reducing the numbers of stainers which attack the cotton in the following season. In Mengo District during May, June and July, 1936, every individual alternative host-plant which bore stainers, however isolated it might be, was found to have been visited by the parasite, which had laid eggs on at least some of the stainers. The percentage parasitism was seldom below 40%, was occasionally 100% and very commonly around 60%. In a collection of 541 stainers\* obtained from numerous localities within 5 miles of Kampala, mostly from *Hibiscus mucranthus*, the parasitism, as indicated by eggs, amounted to 61% and the actual parasitism was probably at least 70% because many stainers had been attacked as nymphs and had lost the eggs of the parasite through moulting. In another collection made in 5 localities on the Kampala—Toro road to Mile 21, and consisting of 58 stainers\*, the parasitism as indicated by eggs was 81%, and in 3 of the 5 localities it was total. A great scarcity of stainers was subsequently observed, and there can be no doubt that it was largely due to the parasite. Stainers can rarely, if ever, be completely eliminated by this natural enemy, even when parasitism amounts to 100%, because the female stainers lay a few eggs before death from parasitism occurs and very young *Dysdercus* nymphs are immune to attack; nevertheless the data obtained in 1936 indicate that this Tachinid fly is an important factor in natural control.

At the end of the 1935-36 season the destruction of the cotton plants caused a large number of adults of the three common species of *Dysdercus* to collect

\* All *D. nigrofasciatus*, but *D. superstilosus* was parasitised to a similar extent.



and breed on a row of six large plants of *Hibiscus esculentus* in the Government Plantation, Kampala. From the 2nd to the 13th of May the dead adults beneath these plants were collected and examined for eggs of this Tachinid, and it was found that within this period the parasitism in *D. nigrofasciatus* increased from 18 to 50% (average 37.5%). The average parasitism of the sexes was 34.4% for males (132 of 384) and 43.3% for females (91 of 210). Similarly the average parasitism of 554 wild adults from the same source which died in captivity during the period May 20th to June 6th was 32.7%. This lower parasitism of the later period appeared to be due to the fact that although a large parasite population was present the majority of the parasites were in the pupal stage. In the case of *D. fasciatus* adults collected dead during May under the same plants the parasitism of males averaged 32% (24 of 75) and of females 43.7% (21 of 48). At the same time *D. superstitiosus* showed a parasitism of 39.8% (41 of 103) for males and 51% (25 of 49) for females. During June and July the parasitism increased very rapidly, as new generations of parasites emerged, and by the end of July the *Dysdercus* population had been reduced by the parasite to insignificant numbers.

The only batches of stainers which were not found to be heavily parasitised in May, June and July, 1936, were those on exposed stored cotton seed and cotton seed dumps at ginneries and stores. Stainers were present in enormous numbers in these situations, but parasitism was always extremely low and seldom exceeded 2% although it was often high on host-plants nearby. It was evident that the parasite does not frequent such situations. There was a slight tendency for the percentage parasitism of stainers on such cotton seed to increase in successive months, but this was almost negligible, and contrasted strikingly with the rapid increase noticed on host-plants. The inefficiency of the parasite on seed dumps is an extremely important point for consideration in connection with control, since dry weather or the cleaning up of the dump causes the stainers on them to disperse far afield and the dumps are therefore serious sources of infestation of cotton plants. It appeared in 1936 that the control of stainers on wild host-plants in the wetter districts could be left to the parasite, but that on seed dumps it could not.

The percentage parasitism in adult stainers on cotton at the end of the 1936-37 season was everywhere low. In central Busoga the parasite was found in March in only 4 of 12 localities examined for this purpose, and parasitism for the whole area, as judged from eggs of the parasite, amounted to only 4% (4 in 101). In Masaka District, also in March, collections were made in 5 localities, and in only one was the egg of the parasite found, the parasitism for the whole area being only 1% (1 in 93). In Bunyoro, Gulu and West Nile, in February, parasitism was exceedingly low. In Bunyoro and Gulu, collections were made in 20 localities, the parasite was found in only 5 of these localities, and parasitism was approximately 1% (6 in 523); in West Nile, the parasite was found in only 2 localities, and parasitism was only 0.4% (2 in 535). At the beginning of March, a collection of 108 adults from kapok at Pabo, Gulu, contained no parasitised individuals; and a similar collection of 95 adults from Moyo, West Madi, also from kapok, contained only 2 specimens with eggs of the Tachinid.

Collections of adult stainers were obtained from cotton on Kampala Plantation in January, February, and March, 1937, with the following results:—

|          |    |             |                |         |
|----------|----|-------------|----------------|---------|
| January  | .. | 372 adults, | 34 parasitised | = 9%.   |
| February | .. | 1,611       | 40             | = 2.5%. |
| March    | .. | 756         | 38             | = 5%.   |

The percentage parasitism on cotton was therefore very low everywhere at the end of the cotton season, and contrasted strikingly with the high figures obtained in the preceding "dead season" on wild host-plants.

(b) *Calliphorid No. 0487.*

During May and June, 1936, at Kampala, about 20 examples of a fly parasitic on *Dysdercus* were obtained from adult bugs, all those determined without doubt being *D. nigrofasciatus*. This fly has the appearance of a Sarcophagid, being grey with silver stripes on the thorax and blotches on the abdomen. As a factor in control it appears to be of very little value since it has not been found subsequently, or at places other than Kampala. It is quite possible that the fly only attacks bugs in a diseased or moribund condition, this being suggested by the fact that its incidence coincided with a fairly intense epidemic of fungus disease. In one instance the fly maggot left its host to pupate 13 days after the death of the bug. The pupal period is 12 to 13 days.

(c) *Fungus Disease*—*Entomophthora sphaerosperma*.

A disease was very prevalent among three *Dysdercus* species at Kampala during the wetter weather of May, 1936. One lot of 150 dead adults collected at the beginning of that month showed nearly 100% infection. Both adults and nymphs are killed by the fungus, the hyphae of which become evident externally during late stages of the disease. The disease was responsible for much difficulty in breeding and rearing bugs—particularly when *Hibiscus* fruits were used as food—a considerable number of records being rendered useless or incomplete by premature death; it became necessary to disinfect with formalin the cages in which bugs had died.

Diseased females became very swollen in the abdomen, the internal tissues of which are disorganised. In the case of the male the permanent extrusion of the genitalia appears to be a symptom of the disease. The legs of bugs immediately at their death from fungus hang limply, probably owing to disintegration of the muscles, and are easily detached. In some instances the disease appeared to cause death in a short time (within a week) but in others its progress was much slower.

Where conditions are favourable this disease can be a factor in the natural control of *Dysdercus*. Very humid conditions coupled with a crowded population appear to be conducive to intense infection.

(d) *Other Natural Enemies.*

Numerous examples of three *Dysdercus* species were found to be infested with a small brown mite which attacked the bugs externally through the soft articulatory integument of the body. It was not determined whether the mites could cause death but they were most numerous on moribund or recently dead bugs.

A bacterial disease (organism not determined) appeared responsible for death of some bugs, but in comparison with *Entomophthora*, it was rare and of little importance.

## V. Annual Cycle.

In the early part of the cotton season, during the first rains and the following dry period, the stainer population is small and scattered, being almost confined to wild host-plants and cotton seed dumps. The cotton plants do not become strongly attractive to *Dysdercus* spp. until the bolls begin to ripen after the

second rains commence; during the months which precede this stage the wild host-plants are much more attractive. A few adults enter the cotton plots during the early months, but they are only isolated wanderers which are far too rare to do damage and which cannot breed extensively because of the dry weather which intervenes between the first and second annual periods of rain. The population as a whole remains on the wild plants and shows no strong tendency to leave them so long as they continue to fruit freely.

In the hotter, drier districts spreading of stainers from wild host-plants takes place on a small scale at the end of the dry period which is terminated by the second rains. This spreading is presumably due to insufficient moisture. Some of the wandering adults reach cotton plots at the beginning of the second rains and wet weather then makes breeding possible. During the second rains, therefore, a large population can develop on cotton in these districts. In the cooler, wetter districts, on the other hand, the spreading from wild plants which takes place at this time in normal years is very slight and seldom gives rise to a population large enough to damage the cotton seriously at any subsequent time of the season.

The size of the population which develops in the second rains clearly depends on, firstly, the numbers of stainers which spread to cotton initially, secondly, the duration of the rainy period, and thirdly, the frequency of rain in that period. Very dry weather would cause a relatively large initial invasion, and an unusually prolonged wet season with frequent rain after the dry weather would make possible abnormally extensive multiplication. A severe stainer infestation in Teso in 1935-36 was attributed to the occurrence of wet conditions extending over at least three months after the movement of stainers to cotton, and the relatively slight infestation in the following season was due mainly to the fact that the weather after the movement of the bugs to cotton was comparatively dry. The extent of multiplication which can take place during the second rains is indicated by figures obtained at Serere Experiment Station in 1935; early in September the estimated adult population was 500 per acre, and in December it was 3,000 per acre.

After the second rains there is usually a period of at least two months of very dry, hot weather before the cotton is uprooted. The dry weather prevents breeding, except perhaps on a very small scale and locally, and the population present is that which developed during the second rains. Soon after the commencement of this dry period the population consists almost entirely of adults, and these begin spreading away from cotton because of insufficient moisture, despite the presence of ample food on the cotton plants. Later in this dry period migration from cotton takes place on a very large scale as a result of the general uprooting of the cotton. The wandering adults feed intermittently on wild plants, but do not remain long anywhere. Breeding is still impossible and heavy mortality occurs, so that the total *Dysdercus* population is greatly reduced.

After the onset of the next wet period (about March of the next year) the surviving adults commence to breed on the wild host-plants and as the wet season advances, more and more wild plants become available to them. The population increases again, this time on wild plants, but the increase is at first slight, as these surviving migrants from cotton are now old and incapable of producing many eggs. Moreover the increase is only temporary, because during this period the insects are very severely attacked by natural enemies (principally the Tachinid *Bogosiella*) and by fungus. The Tachinid appears



to frequent the wild plants much more than cotton. These natural controlling factors maintain the *Dysdercus* population at a very low level throughout the first rainy period (when the cotton is sown) and during part of the succeeding dry period, and it is not until the end of the latter, when spreading to cotton again begins, that the stainers reach places where the parasites do not cause any appreciable reduction.

When, in the hotter districts, the dry weather between the first and second rains is shorter or less intense than usual, the *Dysdercus* individuals appear to be entirely satisfied with the conditions which prevail on wild host-plants until after the second rains. The population remains small, in spite of breeding, because heavy parasitism is maintained. The insects do not move to cotton until the advent of the final dry weather of the season, when the wild plants die back; there is then no scope for extensive breeding on cotton, and the population remains low to the end of the season. This course of events appears to be merely an extreme form of the more normal course, in which some adults spread to cotton just before the second rains, but the majority remain on the wild host-plants until the latter die back after the rains. Those bugs which spread before the rains are markedly less numerous than those which do so afterwards, but the former breed on the cotton plots and give rise to a population in the plot which is very much larger than that of the later migrants from wild plants. The few earlier migrants are therefore a much greater menace than the more numerous later ones.

## VI. Measures for Control.

In connection with prevention or reduction of damage by stainers, the following considerations emerge in a review of the information obtained to date in Uganda: (a) ginnery compounds, (b) compression of the period of sowing, (c) rapidly maturing varieties, (d) regular and frequent harvesting, (e) destruction of bushes affording shade in cotton plots, and (f) collection and destruction of the insects.

(a) In some areas at least, as in parts of Buganda and Bunyoro in 1936, the presence of a continuous litter of seed exposed in the open in ginnery compounds and their environs, is an important factor in the maintenance of a seriously high stainer population at such centres during the close season. As stated in the section on natural enemies, the parasites are usually absent, or scarce, among *Dysdercus* on seed heaps, and the conditions in general are ideal for rapid and large scale breeding of the bugs on exposed seed, especially during the rainy period of April to June. Even in drier weather breeding continues, though feeding may be restricted to seed lying in places shaded during part of the day (alongside walls, under platforms, or on the edges of verandahs of buildings) and to seed with an overgrowth of weeds, which provide shelter and, in the case of weeds, moisture also. These remarks apply also to railway stations and similar places where cotton seed is handled and spilled.

Moreover, the breeding and feeding of bugs on diseased seed may well be of much importance by causing *Nematospora* infection to be carried by the insects so bred to the cotton plants of the following season. It is realised that some litter is inevitable during the ginning season, but a weekly clearing of the seed sufficiently exposed to be damp, and of all weeds near places where seed is handled, is quite practicable and should be enforced. This applies also during bagging and removal of seed for shipment, which may continue for weeks after the season's ginning has ceased.

(b) Compression of the period when sowing is done in any particular climatic district would be a simple method of achieving great reduction of the damage caused by all cotton pests. In some areas, the series of sowings of adjacent plots may be spread over a period of 5 months, or even longer, and those insects which infest the earlier sowings are able, after increase, to spread and infest later sowings in succession as their preferred type of food becomes available; the final result as regards damage is that of growing a slowly-maturing variety, much intensified by the continuous supply of suitable food.

Instances have occurred where cotton has been sown on successive dates commencing before the uprooting of plants of the previous crop. This means the complete elimination in such areas of a close season which latter is generally recognised as an extremely beneficial measure in control of cotton pests. The longer the sowing period in any given locality the greater is the opportunity for insect damage, and this is further increased by a corresponding reduction of the close season.

While it is realised that important practical difficulties may preclude general or great reduction of sowing period being effected, it is felt by the writers that restriction of sowing to a period of 4 months, in the wetter areas at least, would give additional yields without incurring reduction of the area sown.

(c) The reasons for advocating the growing of rapidly maturing varieties (producing the requisite quality and yields of lint) are discussed in (b) above.

(d) Apart from other considerations, such as the loss or soiling of lint which occurs during high winds or storms when harvesting is not frequent and regular, open bolls left available for feeding by *Dysdercus* allow the bugs to breed with maximum rapidity, and to cause greater damage during a given period than would otherwise occur. Open bolls should therefore not be left in the field longer than is necessary for their full maturation.

(e) In Bunyoro, Gulu, and West Nile, very many cotton plots are on recently cleared land on which the stumps of trees remain and sprout, producing low bushes with very dense foliage which affords deep shade. The soil under such bushes remains moist long after that of the rest of each plot is completely dry. Stainers cannot breed where the soil is dry, but they utilise the soil under these bushes to a very great extent and find it moist enough for their requirements when breeding elsewhere is impossible. Adults and nymphs of all ages make these bushes their headquarters in dry weather and wander from them to the neighbouring cotton plants for feeding purposes only. In dry weather the cotton plants themselves do not afford sufficient shelter. In the heat of the day it very frequently happens that no stainers can be found on the cotton although hundreds are present in the foliage of bushes growing amongst the cotton plants.

There can be no doubt that breeding would be very greatly reduced by the simple procedure of cutting down these bushes systematically and ensuring that there is no deep shade in, or very close to, the cotton plots.

(f) This is placed last, not because it is of least importance, but for the reason that if the recommendations which follow are generally applied, some of those above become of little or no importance in connection with *Dysdercus*. Observations have shown that the first important movement of stainers to cotton commences about the time of the opening of the first bolls, and that this migration is normally restricted to a comparatively short period. A weekly collection and destruction of the bugs during six successive weeks starting

with the ripening of the earliest bolls will, if thoroughly and regularly done, effect an enormous reduction in the numbers (and damage) of stainers which would otherwise result from the rapid breeding possible during wet weather with ripe cotton seed as food.

As has been proved on experiment stations, control by collection is *not* impracticable, especially if carried out before any nymphs can be produced. The African cotton-grower will quickly appreciate the value of such action, as was demonstrated to the senior author some ten years ago when he observed an uneducated peasant, without any guidance other than his own observations, collecting and killing *Dysdercus* from his cotton; the correct reason for his action was given by him when questioned. To give full benefit such collection must, of course, be done generally by the cotton-growers to prevent reinfestation from adjacent plots.

The possibility that any measures of control simpler than those advocated above may be evolved in the near future and be applicable in this country, is so faint as to be ignored. (Chemical methods cannot yet be recommended for application by Uganda natives). In consideration of this fact, every effort should be made continuously to impress on growers, by educational, administrative and similar means, the necessity for action at the appropriate times along the lines suggested. A start has been made by the recent publication of a leaflet in three vernaculars (combined with a similar account of Pink Bollworm) which gives a brief account of habits and control measures; in addition a limited number of posters for use in schools, with coloured illustrations of insect stages and damage prepared with the assistance and guidance of the senior author have been supplied by the Empire Cotton Growing Corporation.

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## REPORT OF THE ENTOMOLOGIST, SERERE, 1936-37.

As last year, attention has been mainly confined to Jassids, *Lygus*, *Helopeltis*, and Stainers (*Dysdercus* spp.).

## Jassids.

Jassid infestation at Serere was again very light during the season 1936-37. As in the preceding season, it reached its maximum in November, and nymph counts were done at this time on the Serere Variety Trials and on the Pedigree Lines to obtain information on the relative resistance of the different varieties. These counts were repeated a month later, when the Jassid population was found to have declined very considerably. The method of counting was to record the number of nymphs on 5 leaves\* on each plant in the sample examined, instead of 10 leaves on each plant as was done in previous seasons. It should be noted that counting 5 leaves per plant gives a rather higher nymph population per 50 leaves than when 10 leaves per plant are examined. Except in the District Variety Trials, samples of 20 plants (*i.e.*, 100 leaves) per plot were examined in all cases; for the sake of uniformity all results are expressed as the average number of Jassid nymphs on 50 leaves. Samples of 20 plants per plot were found to give adequate results when dealing with average populations of about 5 or more nymphs per 50 leaves. The following tables summarize the results obtained.

(i) *Combined Variety, Spacing, and Sowing Date Trial* (3'  $\times$  1½' spacing only). Average number of Jassid nymphs on 50 leaves.

A. VARIETIES (ALL SOWING DATES)  $\times$  TIMES OF COUNTING.

|         |    | November. | December. | Combined. |
|---------|----|-----------|-----------|-----------|
| S.G. 29 | .. | 4.6       | 1.8       | 3.2       |
| S.P. 89 | .. | 3.7       | 1.3       | 2.5       |
| S.P. 88 | .. | 11.0      | 5.2       | 8.1       |
| S.P. 20 | .. | 9.2       | 3.0       | 6.1       |
| S.P. 84 | .. | 10.1      | 4.3       | 7.2       |
| S.P. 87 | .. | 10.1      | 4.7       | 7.4       |
| L.S.D.  | .. | 3.7       | 1.9       | 2.1       |

B. SOWING DATES (ALL VARIETIES)  $\times$  TIMES OF COUNTING.

| Sowing date. |    | November. | December. |
|--------------|----|-----------|-----------|
| May          | .. | 7.2       | 1.5       |
| June         | .. | 4.3       | 1.0       |
| July         | .. | 10.7      | 2.9       |
| August       | .. | 10.4      | 8.1       |
| L.S.D.       | .. | 4.0       | 3.5       |

\* Full grown, full sized, but not old leaves—*i.e.* those on which Jassid nymphs are most likely to occur—otherwise selected at random.

(ii) *Miniature Variety Trials.*

## AVERAGE NUMBER OF JASSID NYMPHS ON 50 LEAVES.

|             | Origin.                      | November. | December. | Combined. |
|-------------|------------------------------|-----------|-----------|-----------|
| S.G. 29 ..  | .. .. .                      | 4.7       | 1.2       | 2.9       |
| S.P. 102 .. | S.G. 29 hybrid .. ..         | 3.6       | 0.7       | 2.1       |
| N. 17 ..    | .. .. .                      | 10.8      | 3.1       | 6.9       |
| S.P. 93 ..  | Nariama .. .. .              | 12.2      | 1.5       | 6.8       |
| S.P. 90 ..  | S.P. 13 through S.P. 84 ..   | 18.3      | 3.9       | 11.1      |
| S.P. 92 ..  | S.P. 14 through S.P. 87 .. { | 14.1      | 3.3       | 8.7       |
| S.P. 99 ..  |                              | 14.9      | 3.6       | 9.2       |
| B.P. 50 ..  |                              | 2.9       | 0.9       | 1.9       |
| L.S.D. ..   | .. .. .                      | 6.7       | 1.3       | 3.3       |

*District Variety Trials.*—On the trial at Serere, Jassid nymph counts were done weekly throughout the season; at all other centres counts were done twice a month by the native variety trial Observers. In the absence of adequate supervision, it was not expected that many of these series of counts would be of much value; but although the counts from some centres were obviously worthless, the majority of Observers seemed to have made at least an honest attempt, and besides that at Serere, two series, done by the Observers at Ngetta and Nyiro, appeared to be thoroughly reliable. In the circumstances this was a satisfactory result. All the trials, except those in Busoga, were visited by the writer about 2 months after planting, and the Observers given instructions about doing the Jassid counts. Ten plants were ticketed in each plot, and the counts were done on these plants throughout the season. Later on, when the Botanist went round these trials, he took with him the Entomological Observer who was doing Jassid counts at Serere, to check those done by the Observers at the other centres. On the occasion of these examinations the Jassid population was nearly everywhere very low, and the size of the samples was too small to give figures of any value when dealing with such small numbers. The following table gives the results of 3 counts done by the writer on trials in Teso early in the season, and of the series done at Serere, Nyiro, and Ngetta. Figures refer to the average number of Jassid nymphs on 50 leaves.

## (a) SAMPLES OF 20 PLANTS PER PLOT.

| Centre.           | Date.        | Local. | S.P. 88 | S.P. 20 | S.P. 87. | L.S.D. | Average at each centre. |
|-------------------|--------------|--------|---------|---------|----------|--------|-------------------------|
| Katakwe           | July .. ..   | 3.5    | 5.1     | 6.4     | 7.1      | ..     | 5.5                     |
| Toroma            | July .. ..   | 2.1    | 4.6     | 5.5     | 5.7      | ..     | 4.5                     |
| Nyiro             | August .. .. | 3.0    | 5.2     | 4.4     | 3.1      | 1.6    | 3.9                     |
| Combined analysis | —            | 2.9    | 5.0     | 5.4     | 5.3      | 1.5    | ..                      |

## (b) SERERE (AVERAGE OF FOUR COUNTS, 10 PLANTS PER PLOT, IN EACH CASE).

|                   |                |     |     |     |     |     |     |
|-------------------|----------------|-----|-----|-----|-----|-----|-----|
|                   | October .. ..  | 1.6 | 3.2 | 2.2 | 2.6 | ..  | 2.4 |
|                   | November .. .. | 3.6 | 5.2 | 3.6 | 4.6 | ..  | 4.5 |
|                   | December .. .. | 1.4 | 3.5 | 1.9 | 2.7 | ..  | 2.4 |
|                   | January .. ..  | 2.9 | 6.6 | 3.8 | 5.6 | 2.2 | 4.7 |
| Combined analysis | —              | 2.4 | 4.6 | 2.9 | 3.9 | 0.8 | ..  |

## (c) NYIRO (AVERAGE OF THREE COUNTS, 10 PLANTS PER PLOT, IN EACH CASE).

|                   | Date.         | Local. | S.P. 88 | S.P. 20 | S.P. 87. | L.S.D. | Average at each centre. |
|-------------------|---------------|--------|---------|---------|----------|--------|-------------------------|
|                   | Aug.-Sept. .. | 6.7    | 9.4     | 7.1     | 9.0      | ...    | 8.0                     |
|                   | Oct.-Nov. ..  | 13.7   | 23.4    | 14.2    | 23.0     | 6.1    | 18.6                    |
|                   | Nov.-Dec. ..  | 5.8    | 9.1     | 4.4     | 10.6     | 7.5    | 7.5                     |
| Combined analysis | —             | 8.7    | 14.0    | 8.6     | 14.2     | 2.4    | ...                     |

## (d) NGETTA (AVERAGE OF TWO COUNTS, 10 PLANTS PER PLOT, IN EACH CASE).

|                   |              |     |     |     |     |     |     |
|-------------------|--------------|-----|-----|-----|-----|-----|-----|
|                   | Oct.-Nov. .. | 3.0 | 3.5 | 4.0 | 6.1 | 1.9 | 4.2 |
|                   | December ..  | 3.7 | 3.6 | 3.4 | 5.7 | ..  | 4.1 |
|                   | January ..   | 5.9 | 6.6 | 4.0 | 6.5 | ..  | 5.7 |
| Combined analysis | —            | 4.2 | 4.6 | 3.8 | 6.1 | 1.1 | ..  |

Taking these series in conjunction with other figures not given here, the following facts emerge:—

(i) The only centre at which there was a moderate Jassid infestation during a considerable part of the season was Nyiro. Here the two more susceptible varieties, S.P.88 and S.P.87, consistently harboured nearly double the Jassid population found on the other two varieties. In spite of this, Nyiro was one of the centres at which S.P.88 yielded best, and a comparison of the yield figures with those for centres with very low Jassid population indicates that this degree of infestation had no effect on yield.

(ii) At all other centres Jassid population was low (in many cases extremely low) till January, when there was a tendency for it to rise sharply.

(iii) At some centres, particularly in the drier districts, there was a well-marked peak in November (though at a low level), after which the population declined, but usually rose again in January. The drop in December followed a period of dry weather, and was almost certainly a reflection of the effect of drought on the plants.

(iv) Differences between varieties become much more marked during the later part of the season.

(v) At some centres the Nyasaland Upland varieties have relatively fewer Jassids in comparison with S.P.20 and S.P.87 than at others. This seems to be an example of environment affecting the relative resistance of varieties. Late in the season the relative position of the four varieties is much the same at all centres.

(vi) It seems hardly necessary to point out that there is nothing in these figures to suggest that Jassids are a pest of any importance in Uganda.



*Varietal Differences.*—Considering all these tables together, the chief results are:—

(a) The high degree of Jassid resistance shown by S.G.29 and its relations S.P.89 and S.P.102, compared with all other varieties except B.P.50.

(b) The resistance of S.P.20 shows up much less clearly than it did last season, when it was practically equal to that of S.G.29.

(c) The increased resistance of S.P.93 (*Nariama* derivative) as compared with its predecessors, it is the first member of this family to show appreciably less Jassid than some U.4's. This improvement had already been indicated by counts in the Pedigree lines last season.

*Jassid Test Cage.*—The erection of this cage was completed early in August. It consists of two compartments, each 21'  $\times$  18'; the roof is 9' high in the centre, and the whole is covered with Staybrite Steel wire gauze, 24 mesh, this being the widest mesh which Jassids cannot get through.

Each compartment was planted with one line of each of the six varieties in the big variety trial at Serere, except that the Jassid-susceptible S.G.23/8 was substituted for S.G.29. The two lines of each variety were planted opposite, so as to eliminate as far as possible differences due to position. After various set-backs, including a severe *Aphis* infestation while the writer was away, a moderately heavy Jassid infestation was produced in one half of the cage, following the introduction of a final instalment of 4,000 nymphs at the end of November. This resulted in pronounced symptoms of the type usually associated with Jassid infestation, but much more severe than the writer has yet observed in the field; on the more susceptible varieties the infestation was at times of the order of 90 nymphs per 50 leaves. The younger leaves were badly curled, showing much yellowish discolouration round the edges, while older leaves had a conspicuous red band round their edges. As the attack persisted, growth was badly checked and flowering practically ceased; this was in striking contrast to the control half, where the plants remained green and vigorous, and continued to put on fresh bolls in large numbers. This contrast was further emphasized by the behaviour of the susceptible S.P.88, which in the control half was the most vigorous and prolific variety, while in the Jassid half it was so badly checked that eventually the Jassids started to leave it for less susceptible varieties which had bigger and greener leaves.

The Jassids showed a marked tendency to congregate on the more susceptible varieties, which showed correspondingly more severe symptoms. The two known susceptible varieties, S.P.88 and S.G.23/8, suffered more severely, and S.P.89 distinctly less than S.P.20, confirming what had already been indicated by counts on the Variety Trials. Of more interest was the fact that S.P.87 and S.P.84, which in the Variety Trials were only doubtfully better than S.P.88, in the cage suffered much less severely than the latter and were little worse than S.P.20.

### Lygus.

Infestation during the 1936-37 season was normal, that is to say it tended to be severe during the first half of the season, but ceased to be of any importance after September.

Two dusting and spraying experiments were done. Neither experiment was successful, the extent to which *Lygus* infestation was reduced by any of the treatments being inadequate to have any significant effect on yield.

The first experiment consisted of 30 plots arranged in 5 blocks, each block being divided into 3 varieties, S.G.29, S.P.88 (Nariama derivative), and S.P.20 (U.4.4.2 derivative); the strips of each variety were sub-divided into two plots, one control, the other to be dusted with Pyrethrum powder. The object of this experiment was (i) to find out whether there was any appreciable difference between varieties in susceptibility to *Lygus*, and (ii) to estimate the loss of crop due to *Lygus*. Leaf damage counts showed a small though highly significant reduction in leaf damage on the treated plots as compared with the control plots. There was no indication of any differences in susceptibility between varieties.

The second experiment was a 4×4 Latin Square planted with S.P.20, the four treatments being (i) Spraying with arsenic-sugar bait, (ii) dusting with finely ground Pyrethrum powder, (iii) spraying with Tobacco-soap decoction, and (iv) control. Leaf damage counts showed a significant decrease in leaf damage in the case of treatments (i) and (ii) as compared with treatments (iii) and (iv), indicating that the former treatments are more efficient in controlling *Lygus* than spraying with Tobacco-soap decoction. Spraying with arsenic bait resulted in a certain amount of scorching of the leaves; though the differences in yield were not significant, the actual yield of these plots was lower than that of the other three treatments, which suggests that it may have had a depressing effect on yield.

### Helopeltis.

Except in Busoga, *Helopeltis* was everywhere rather prevalent in the districts East of the Nile, the worst infestations being in parts of Teso and in the districts around Mt. Elgon. At Serere itself infestation on the Experiment Farm was very light, but counts in the District Variety Trials elsewhere afforded striking confirmation of the differences in varietal susceptibility indicated by a count on a single variety trial last season. The method of estimating the degree of infestation was to count the number of plants showing *Helopeltis* lesions in each plot; in the following tables the results are expressed as the number of attacked plants per acre.

#### (a) BUDAMA AND BUGWERE.

| Centre.              | Date.    | Local. | S.P. 88. | S.P. 20. | S.P. 87. | L.S.D. | Average at each centre. |
|----------------------|----------|--------|----------|----------|----------|--------|-------------------------|
| Kachumbala ..        | 14-10-36 | 3,306  | 6,897    | 2,061    | 1,374    | 2,308  | 3,410                   |
| Kibale ..            | 13-10-36 | 402    | 946      | 207      | 545      | ..     | 525                     |
| Mulanda ..           | 15-10-36 | 1,271  | 1,685    | 350      | 583      | 687    | 972                     |
| Combined analysis .. | ..       | 1,659  | 3,176    | 873      | 834      | 726    | ..                      |

#### (b) BUSOGA.

|                      |          |     |     |     |     |     |     |
|----------------------|----------|-----|-----|-----|-----|-----|-----|
| Vukula ..            | 17-10-36 | 350 | 428 | 181 | 181 | 167 | 285 |
| Bugaya ..            | 22-10-36 | 143 | 233 | 26  | 39  | ..  | 110 |
| Bulopa ..            | 22-10-36 | 52  | 337 | Nil | 169 | 207 | 139 |
| Iganga ..            | 19-10-36 | 285 | 700 | 52  | 78  | 635 | 279 |
| Combined analysis .. | ..       | 207 | 425 | 65  | 117 | 147 | ..  |

## (c) LANGO.

| Centre.              | Date.    | Local. | S.P. 88. | S.P. 20. | S.P. 87. | L.S.D. | Average at each centre. |
|----------------------|----------|--------|----------|----------|----------|--------|-------------------------|
| Ngetta .. ..         | 25-11-36 | 194    | 220      | 220      | 181      | ..     | 204                     |
| Aduku .. ..          | 26-11-36 | 402    | 583      | 337      | 143      | ..     | 366                     |
| Kaberaimaido ..      | 27-11-36 | 259    | 1,114    | 194      | 156      | 311    | 431                     |
| Combined analysis .. | ..       | 285    | 640      | 251      | 160      | 141    | ..                      |

These counts were all done by the same native observer; where his figures were checked they agreed closely with those obtained by the writer.

The most striking feature of these tables is the constancy of the order in which the varieties appear, giving a significant result even when dealing with such small numbers of attacked plants as at Bulopa; while at Bugaya, when dealing with the distribution of only 34 attacked plants in a  $4 \times 4$  Latin Square, though the result is not significant, the varieties are in their usual order. The only exception was at Ngetta, where the trial had been badly damaged by hail. *Helopeltis* thus displays a sensitivity to differences in variety at least as great as that shown by Jassids.

An interesting point was that while S.P.88 is markedly susceptible to both *Helopeltis* and Jassids, S.G.29 ("local" in table (a)), which has a high degree of Jassid resistance, comes next to S.P.88 in order of susceptibility to *Helopeltis*; and S.P.87, which often harbours a relatively high Jassid population, is one of the least susceptible to *Helopeltis*.

#### Dysdercus spp. and Other Insects Responsible for Staining.

During the past season a record has been kept of the Stainer population on the main increase farm at Serere, using the method worked out by Pearson at Barberton\*. By this means it is possible to obtain a reasonably accurate estimate of the number of Stainers per acre and a reliable record of the changes in population throughout the season. Such records kept over a number of seasons should provide much accurate information on the course of Stainer infestations and the factors which influence them.

Owing to the small population present on wild food plants, adult stainers invaded the cotton late and in very small numbers. Dry weather during the greater part of October and in November prevented breeding, and Stainers remained scarce. Heavy rain early in December, apparently accompanied by a further influx of Stainers, stimulated breeding, which was reflected in a sharp rise in the number of last instar nymphs at the end of the month. After this the population increased rapidly, rising from a little over 100 adults per acre at the beginning of December to over 4,000 adults per acre in the middle of February. This was too late to affect the main crop, the harvesting of which had been completed towards the end of January, and which was very free from *Nematospora* staining; but it destroyed any prospects of a top crop, as a large majority of the bolls set after the heavy rain in December were totally stained.

\* Thanks are due to Mr. Pearson for his assistance in sending a very detailed account of the latest modifications of his method, which has not yet been published in its final form. For a preliminary account of his investigations see his paper "Preliminary Observations on Cotton Stainers and Internal Boll Disease in S. Africa"—*Bull. Ent. Res.* XXV (1934), pp. 383-414.



*Note on Staining.*—It has often been assumed that, apart from rain-stained cotton, the bulk of staining is due to *Nematospora* infection carried by *Dysdercus* spp. As far as the main crop was concerned, this was not true of the past season, when *Nematospora* staining was negligible. However, 20 to 25% of even the first pickings was classed as "fifi", nearly all due to damage by insects, fungi, and bacteria. The boll-analyses shown in the following table indicate how this was made up.

| Date.       | No. of bolls examined. | % locs showing <i>Nematospora</i> stain. | % bolls attacked by bollworms. | % bolls discarded due to other causes. |
|-------------|------------------------|------------------------------------------|--------------------------------|----------------------------------------|
| 30-10-36 .. | 35                     | 14                                       | 49                             | 17                                     |
| 7-11-36 ..  | 50                     | 9                                        | 60                             | 14                                     |
| 13-11-36 .. | 69                     | 8                                        | 55                             | 7                                      |
| TOTAL ..    | 154                    | 10                                       | 54                             | 11                                     |
| 2-1-37 ..   | 93                     | 12                                       | 27                             | 8                                      |
| 16-1-37 ..  | 60*                    | 28                                       | 68                             | 8                                      |

\* The extreme end of the main crop; mostly undersized bolls.

The samples were obtained by collecting all bolls just beginning to split, from certain lines in the Stainer-recording units, so they can be taken as representative of the field as a whole. In each sample collected, all bolls showing staining due to causes other than *Nematospora* infections were discarded (columns 4 and 5). All locs in the remaining bolls were examined for *Nematospora* stain (column 3). Much of the damage under all the headings in the table was very light, but (except that much of the stain in column 3 was not obviously associated with insect punctures and only doubtfully attributed to *Nematospora* infection) this table gives a fair indication of how the damage should be apportioned. Bollworm damage was divided between *Argyroplote* and *Earias*, both of which were very abundant, perhaps abnormally so. The latter was also responsible for extensive shedding of buds and young bolls in September and October. The damage done by these bollworms is out of all proportion to the number of larvae actually found in the bolls, for in both cases young larvae often bore in the boll-walls, and either perish there or wander off elsewhere; however, their burrows frequently permit the entry of fungi and bacteria into the lint cavity, and thus are followed by more or less extensive rotting of the contents of the locs.

In the 1935-36 season, owing to a much larger Stainer population in the main crop, there was a considerably larger proportion of *Nematospora* stain; but even so, probably the greater part of the stained cotton in the first half of the crop was due to causes other than *Nematospora* infections.

These conclusions are at variance with statements made in connection with previous investigations in Uganda on the subject of staining, and it is clear that more detailed investigations into the causes of staining are necessary before it can be said with certainty what proportion of this damage is attributable to each of the various pests concerned.

A. M. GWYNN,  
*Entomologist.*

## PINK BOLL WORM (*Platyedra gossypiella*, Saund.)

By T. H. C. TAYLOR, *Entomologist.*

Work on Pink Boll Worm has been continued throughout the year. A detailed account of this insect was published in the last Annual Report, and the observations which follow are to be regarded as supplementary to that account.

1. *Recent Spread.*—The insect first appeared in Busoga at the end of the 1935–36 season, when it was found at Kamuli only. In the 1936–37 season very extensive spreading took place in Busoga, particularly southwards. At the end of this season, Pink Boll Worm appeared to be present in every cotton plot in the south-western part of the district, but in central and north Busoga its occurrence was much less general, and in most plots it was absent. Surveys showed that it has not yet spread appreciably eastwards of the line Bugaya–Bukova–Naigobia–Kiyunga–Busiro–Jinja, but it will probably reach the Kenya border during next season. The fact that the insect has established itself more rapidly and generally in the south-west of the district than elsewhere is probably attributable to the greater frequency of cotton plots and alternative host-plants in the south-west.

The most noteworthy development of the 1936–37 season was the discovery of the insect in Teso for the first time. Its entry into Teso was apparently effected from Kaberamaido County of Lango, and it is now established in a number of localities in Kasilo County of Teso. It appears, however, to be confined to Kasilo, and therefore almost the whole of Teso can still be said to be free from it.

Pink Boll Worm has also appeared in Chua for the first time, at Kitgum and Paranga.

In Masaka District, this insect is now very generally distributed. In the northern part of Buddu County it is present in every plot. Towards the south of the district it becomes less prevalent and is only occasionally present. The most southerly point which it is known to have reached is 35 miles south of Masaka Township, but there is good reason to believe that it extends intermittently to the Tanganyika border.

2. *Alternative Host Plants.*—Pink Boll Worm was found commonly in *Hibiscus esculentus* at Kampala during the 1936 dead season for cotton. In this plant it survived the whole of the period when there was no cotton. In the wetter and cooler areas of the Protectorate, *H. macranthus* and *H. esculentus* are to be regarded as the principal sources of infestation of the new crop, but neither species is sufficiently common to cause survival on a large scale. Elsewhere, *H. macranthus* is absent, and *H. esculentus* is rarely fruiting at the time when there is no cotton. The insect was found in *H. esculentus* at Attiak (Gulu District) in 1937, but the plants were nearly dead when the cotton in the same neighbourhood was being uprooted.

Observations on a great variety of plants have been continued during the year but no new host plants have been found. Special attention was paid to the fruits of *Sterculia cinerea* and Kapok in Gulu, and West Nile, but no trace of Pink Boll Worm was found in them.

3. *Resting Stage*.—Larvae which were artificially induced to enter the resting stage in January, 1936\*, in West Nile produced moths from July to December, 1936. The duration of the resting stage varied from 6 to 10 months. From February onwards the larvae were kept in glass tubes, plugged with cotton wool, on a bench in the laboratory at Kampala. No water was added at any time. It may safely be assumed, judging from previous observations on the effect of moisture on resting larvae, that if these larvae had been placed in the open and had received normal amounts of dew and rain, they would have pupated and produced moths much sooner, almost certainly before the end of May.

In February, 1937, the possibility of the occurrence of the resting stage in the hotter and drier parts of the Protectorate was again fully investigated in Gulu and West Nile Districts. Large collections of larvae were obtained from mature and immature bolls on the plants and from seed cotton in native markets and ginneries. All of these larvae pupated and produced moths without undergoing a resting period. At Rhino Camp, however, resting larvae were obtained, in special circumstances. A plot of cotton, very close to the ginnery, was heavily infested at the time when it was about to be uprooted. The native pickers spread the seed cotton on a mat to dry, in very hot sun. Many larvae were completing their feeding in the open bolls when the crop was picked and were removed with the crop, and these were subjected to an abnormally high temperature, and probably abnormally low humidity, on the mat. Fifty of the larvae were collected and kept in a cloth bag, full of seed cotton; and at the same time, and in the same plot, collections of larvae were made from open and unopen bolls on the plants, and these also were placed in cloth bags full of seed cotton. After 10 days, the bags were opened and the contents very carefully examined. It was found that 60% of the larvae from the mat had entered the resting stage, and that all those from bolls on the plants had pupated. The resting larvae included some which were inside typical "double-seeds", and the latter were the first "double-seeds" seen by the writer in Uganda. No larvae already in the resting stage could be found on the mat, and none has ever been seen by the writer in the field or in ginneries in Uganda, but it is almost certain that the larvae collected from the mat would have entered the resting stage in any case and that their behaviour was attributable to the conditions to which they were subjected on the mat, together with the fact that they had fed previously for several days on ripe seed. Some of these resting individuals have since produced moths in Kampala, but the majority are still larvae, in typical resting cocoons or double seeds (June, 1937).

In special circumstances, therefore, larvae are caused to enter the resting-stage in the field in Uganda. The percentage which rest is exceedingly small, since the great majority of larvae become fully grown in immature bolls and leave the bolls before they open; and the resting larvae which survive ginning are, with few exceptions, only those in "double-seeds", and these are very rare. The Agricultural Officer, West Nile, and also the Manager of the Rhino Camp ginnery, repeatedly searched for "double-seeds" at the ginnery during the 1936 ginning season, but they found none. The writer has made very many inspections of seed in ginneries, in three successive seasons and many different parts of the country, without finding any.

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\* Ann. Rep. Dept. Agric., Uganda, 1935, Part II, p. 25.



Since the resting larvae are in picked cotton, almost all of them are taken to ginneries. It is only in the neighbourhood of ginneries, therefore, that resting larvae can affect the degree of infestation in the following season. The Rhino Camp ginnery is the only one in West Nile, and the resting larvae from the whole district therefore congregate in this one locality. Every year, the infestation in the immediate vicinity of this ginnery is unusually severe, and while the available evidence indicates that this is mainly due to failure to uproot and destroy the cotton plants thoroughly at the end of each season (a common failing near ginneries and riverside ports) it now appears that resting-larvae may be a contributing factor. There can be little doubt, however, that most of them produce moths during the rainy season when the next season's cotton is planted, and at this time the insect cannot breed because the cotton is too young.

The conclusions with regard to the resting stage are, as last year, that it can never be an important factor in Uganda, except perhaps in very unusual weather conditions; and that in the cooler and wetter parts of the country it cannot occur at all.

4. *Extent of Damage and Control.*—The average percentage infestation of bolls has remained low in all infested areas, and since, in almost all localities, the infestation has been negligible until the extreme end of the season, the damage to the crop as a whole is very slight. The figures obtained for the 1936–37 season were entirely comparable with those for the previous season.

The margin of safety, however, was again found to be very small throughout the Protectorate. Any slackening of the enforcement of the uprooting and burning of cotton at the end of each season would have disastrous results, and more thorough destruction of the old cotton is still desirable in Gulu and West Nile Districts, and also in the north of Bunyoro. The growing of bahmia (*Hibiscus esculentus*) should not be encouraged in the wetter areas. Appreciable damage is done in many localities, although not over wide areas, as a result of the planting of cotton in different months in adjacent plots. This practice, although unavoidable to some extent, is often carried to extremes, and it is then most harmful. It provides the pest with a long succession of plants in the condition which it prefers for breeding, and enables the pest to multiply for a longer period than would otherwise be possible. The severe infestations which commonly occur on Experiment Stations (Kampala and Bukalasa) are attributable to the planting of cotton during several successive months for experimental purposes. At Kiguli in Buruli, great damage was done locally because the owner of a large plantation decided to experiment with different sowing dates. He sowed cotton in every month from February to September, and from August onwards his crop was rendered almost worthless by Pink Boll Worm, and other cotton pests to a lesser extent. In Masaka District, July and September plantings in adjacent plots are frequent, and unusually severe damage by this pest results.

## ANNUAL REPORT OF THE PLANT PATHOLOGIST, 1936.

The Plant Pathologist was stationed at Bukalasa until March 11th, when he was transferred to Kampala. The time spent at Bukalasa was occupied in field observations on Wilt disease of cotton, which were reported in the 1935 Annual Report.

During 1936 the plans for the new Agricultural Laboratories were drawn up in consultation with the other technical officers to be stationed at Kawanda, and the final plans were sent to the Architect with whom several consultations were held.

Since July much time has been occupied in the preparation of material for and proposed publication "Agriculture and Agricultural Research in Uganda" the most of the editorial work and typing has devolved upon the Plant Pathologist as Chairman of the Committee in charge of this publication. Towards the close of the year this was practically a full-time occupation.

### Cotton Diseases.

#### BLACK ARM (*Bacterium malvacearum*).

The results obtained from the experiments conducted during 1931-35 on this disease have shown that varieties of cotton highly resistant to Black Arm can be produced in Uganda; the methods used in these experiments to estimate the degree of attack have now been incorporated and further elaborated in the routine of the officers of the Botanical Section engaged in cotton breeding and their 1936 results are given in their reports. For the present any further detailed investigation into this disease in Uganda appears to be unnecessary in view of the results already obtained by the methods indicated.

#### WILT DISEASES.

The outstanding fact discovered in 1936 in work on these diseases in Uganda is that the most important cause is *Verticillium dahliae*. This fungus was isolated from over 90% of the samples of diseased plants received from all infected districts during the early part of the 1936-37 cotton season. Previously, various strains of *Fusarium* had been determined as causes of Wilt disease of cotton in Uganda, and inoculation experiments carried out during 1936 proved that some of the strains isolated from wilted cotton were capable of reproducing the disease when inoculated into sterilised soil in which cotton had been planted. In similar experiments *Verticillium dahliae* also reproduced typical Wilt disease, and in view of the field observations there is no doubt that at present *Verticillium* is more important than the *Fusaria*.

Experience has shown that it is quite impossible to distinguish between the symptoms caused by these fungi in the field and the descriptions of the disease published in previous reports apply equally to all types found hitherto in Uganda. *Verticillium dahliae* has not been recorded previously in Uganda nor has it ever been isolated here in the past when large numbers of fungi were isolated from soil. It is slow growing on most of the common laboratory media and on this account it may have been missed in this work. When cotton plants contain both *Fusarium* and *Verticillium* in the woody tissues, a not infrequent occurrence, it is often very difficult to demonstrate the presence

of the latter, which becomes overgrown by the *Fusarium*. I am indebted to the Imperial Mycological Institute for the determination of this *Verticillium*, which has also been isolated during the year under review from wilted plants of *Abroma augusta*, cassava, simsim and a native species of *Triumfetta*.

During the year the Wilt diseases of cotton were identified from a much wider area of Uganda than in previous years, and at present the only cotton growing areas from which it has not been determined are Lango, Acholi, West Nile, Toro and Ankole, the last two being of very minor importance. In the Eastern Province the disease occurs only on isolated plants scattered over the whole area, and in Teso District it has not yet been found in the northern and eastern counties.

In Buganda during 1936 on the whole the disease was less in evidence than in previous years, though in Bulemezi and especially on the Bukalasa Experiment Station, it was encountered rather more frequently. Hitherto it has not been possible to assess the damage to the cotton crop of this Province caused by the disease, but it is certainly still very small, in spite of the disease having been known to occur here for over 10 years. Evidence at Bukalasa shows that there is every probability that the disease extends in the soil year by year, whether or not susceptible crops are grown, but it is still too early to estimate the rate of this increase as also that of the spread from plot to plot throughout the country.

In native plots in Buganda cases have been seen where whole patches of plants have become infected, but such cases are still comparatively rare and as a rule infection remains limited to individual plants scattered through the plots or to very small groups of plants. Until further evidence is accumulated it is impossible to forecast whether or not this disease will in the future have any serious effect on cotton production in Uganda. The present position is complicated by experience in Masaka District: in the 1934-35 season heavy infection was found in some parts of this district but in the 1936-37 only occasional infected plants could be found. The cause of this almost complete disappearance of the disease is unknown, but it is suspected that climatic and soil conditions affect the resistance of the cotton plant to attack.

No difference could be found in inoculation tests or in the laboratory between the isolations of *Verticillium* obtained from different parts of Uganda, nor between the cultures originating from cotton, cassava, *Abroma* and simsim. Cross-inoculation tests have shown that the fungus from *Abroma* and cassava is pathogenic to cotton and *vice versa*. This leads to a consideration of the possible distribution of the fungus in affected planting material of cassava or by the transport of infected soil on the tubers of this plant. There seems little doubt that the cotton Wilt diseases have been distributed in the cotton seed used for planting, though direct evidence on this point has not yet been obtained in Uganda.

During the year evidence was obtained that *Verticillium dahliae* is indigenous in Uganda. Cotton seed from Bukalasa taken from wilt-free plants was sown at Kampala on land which as far as is known had never been sown with cotton before. The plants in this plot developed a serious attack of the disease and when examined at the close of the season it was found that a total of 59% of the plants had become infected; many of these infected plants had died during the course of the season. Close to this plot was another planted with *Abroma augusta* and about 5% of the plants in this were infected with



*Verticillium* wilt. On *Abroma* the disease causes a wilting of the uppermost leaves of one or more branches, followed by the death of the affected branches to within about nine inches of ground level. The dead branches are covered with a layer of spores of several species of *Fusarium*, which are considered secondary. From the base of the plant other new shoots arise, only to die back in succession after they have attained a height of one to four feet. Apparently few plants of *Abroma* are killed out completely by the disease.

The *Verticillium* wilt of cassava has hitherto been found only at Bukalasa, where it occurred on land on which cotton had been infected about two years before the cassava was planted. The reaction of a number of cassava varieties to attack by *Verticillium* is being investigated, and in inoculation experiments conducted at Kampala it has been found that the variety "bitamisi" is comparatively resistant.

Hitherto no variety of cotton grown in Uganda has proved completely resistant to Wilt disease, but attempts are being made to isolate resistant strains from local varieties and to obtain others by hybridisation. A number of wilt-resistant cotton varieties were obtained from the U.S.A., but a few cases of Wilt were found at Bukalasa on three of these varieties in 1936.

Attempts were made to assist this work of isolation of wilt-resistant cottons by means of laboratory inoculations. Seed of three promising varieties was sown in fibre pots in sterilised soil inoculated with pathogenic *Fusaria*. At the time this work was carried out the existence of the form of Wilt disease due to *Verticillium* had not been discovered in Uganda. All plants surviving the inoculations were transported in their pots to Bukalasa, where they were planted intact in soil known to be infected with Wilt. The growth of these plants was very slow and it is now evident that under local conditions this method is not likely to give satisfactory results. It appears preferable to plant the cotton in the field after infected material has been placed in the soil in which each plant is grown, in order to ensure as far as possible that each plant is exposed to the same risk of infection. Work in the coming cotton season will be along these lines.

At Bukalasa one group of varieties has proved extremely interesting in its reaction to the disease. Instead of the plants being completely killed by the disease, as is often the case with other varieties, those of this group shed their larger leaves but retain their bolls and eventually develop a second flush of foliage. The bolls ripen in the usual manner and in 1936 these varieties produced a satisfactory crop in spite of being infected with Wilt. It still remains to be seen whether the cotton produced by these plants is of satisfactory quality, but in the absence of any high degree of resistance to Wilt in Uganda cottons it may be possible to breed varieties of this "tolerant" type capable of producing good crops in spite of the disease, and from this viewpoint the discovery of this "tolerance" to Wilt disease may prove extremely important.

#### RHIZOCTONIA DISEASE (*R. bataticola*—*Macrophomina phaseoli*).

During 1936 a number of plants attacked by this disease were sent in by the field staff of the Department as suspected cases of Wilt. Detailed field examination of one case at Mulondo, in which several large patches of plants were affected, was made and the results indicated that water-logging of the soil is probably a predisposing factor to attack by this fungus. The symptoms, both external and internal, shown in some cases of this disease are very difficult to distinguish from those of Wilt disease, especially as the wood of the stem

often exhibits dark streaks. Usually, however, the minute black sclerotia of *Rhizoctonia* are found in the bark and wood of the roots of infected plants, though this does not rule out the possibility of mixed infections by Wilt and *Rhizoctonia*. Final diagnosis in such cases can only be made in the laboratory. The disease in 1936 appeared to be more common in occurrence than in previous years, though the more numerous reports received may have been only a direct result of the more intensive inspection of native cotton plots consequent upon the search for Wilt disease carried out in all districts.

### Other Plant Diseases.

#### TOBACCO.

A visit was made to Bunyoro to inspect the native tobacco in company with the Agricultural Officer, Northern Province. Mosaic disease was common, but at the time of the visit it was not serious in any part of the district. In many cases it was obvious that the disease had been spread from plant to plant at the time of transplanting from the nursery beds, as it frequently occurred on three or four successive plants in one row. It should be possible to prevent this by careful examination of plants before their removal from the nursery beds, and all those found infected should be left in the beds, together with their immediate neighbours, and should not be handled when the remaining plants are removed for transplanting. After the beds have been cleared all the infected plants should be destroyed. It is not known whether any indigenous plants or other crops cultivated in Uganda are susceptible to this disease. To obviate the risk of transmission of the disease to healthy plants at the time of "topping" it would be advisable to rogue out all infected plants as soon as these are noticed in the fields. The native instructors are familiar with the disease and it should be an easy matter to destroy the infected plants, especially as much of the leaf produced by them is of no value as it does not colour uniformly in curing.

Curly Leaf Disease is of frequent occurrence in Bunyoro and cases were found also in Ankole. This is of less importance than Mosaic as the infected leaves are saleable unless they are severely distorted.

Elworm (*Heterodera marioni*) has been found on some plants in Bunyoro and where it occurs in nurseries these should be abandoned in favour of new sites. Tobacco appears to be rather susceptible to the effects of attack by these worms and affected plants make poor growth. All plants found infested at the time of transplanting should be destroyed as they assist in the spread of the worm through the fields. If the infestation of land by these worms becomes serious, very little can be done to control them under the conditions of native agriculture.

Two cases of attack by *Fusarium* causing a Wilt disease have been found in Ankole and this is the only record of this disease in Uganda. The fungus belongs to the *Elegans* section of the genus and is probably *F. oxysporum* var. *nicotianae*, known to cause a similar disease in the U.S.A.

One case of "Hollow Stem Disease" was found at Bukalasa, and the bacterium isolated from the affected tissues has been identified by Dowson as *B. aroideae*. No cases of this disease were found in Bunyoro or Ankole at the time these areas were visited. Affected plants die off after topping and show a rot of the pith commencing at the wound made in topping the plants, and proceeding downwards; the pith disintegrates and leaves the woody cylinder of the stem intact and hollow. The plants die off, the leaves turning yellow.

A peculiar disease was reported from Ankole in January, 1937; affected plants showed yellow and brown spots on the leaves. The spots were slightly sunken below the general level of the leaf tissues and the tissues were dead or dying. Usually the spots were extremely numerous on the affected leaves and the plants were easily distinguished from a distance. No fungus was found in the tissues of the spots and the disease has not been identified with any occurring in other countries. Reports stated that it appeared suddenly over a wide area in Ankole, but that it diminished in intensity after a few showers of rain. There is a possibility of it being due to a virus, but present opinion tends to the view that it is physiological in origin.

#### SIMSIM.

A critical examination of the common leafspot diseases of this crop in Uganda resulted in a differentiation of two diseases formerly confused. One of these is due to *Cercospora sesami*, Zimm., which causes small, usually rounded spots, white to light yellowish brown on both surfaces of the leaves and papery in texture. Those due to the second fungus, *Cylindrosporium sesami*\*, Hansford, are larger and more diffuse than the former, irregularly angular to rounded, sometimes indistinctly zonate, with slightly raised margin, dark reddish brown; the spots vary from 2 to 5 mm. in diameter, but are often confluent and larger especially around the edges of the more mature leaves of the plant. The spots of this second disease are often very numerous and sometimes whole simsim plots appear brownish when viewed from a distance. The disease often spreads to the younger leaves at the top of the plants and although it is difficult to assess the damage to the plants there is reason to believe that this may be important in severe infections.

Two bacterial diseases of simsim were found at Kampala; one caused a dark red rot of the interior of the stem, commencing from wounds probably due to insect attack at the top of the plants, and the other causing a water-soaked dark green rot also commencing from the top of the plant and gradually extending downwards. Plants attacked by the latter disease soon dried up and turned black. The causative bacteria have not yet been identified and neither disease has been identified in other parts of the country.

#### CASSAVA.

A bacterial leaf spot and stem disease has been found at Bukalasa and was common on some varieties grown there, while others appeared to be immune or at least very resistant. The casual bacterium was isolated and inoculated into young shoots of cassava cuttings, on which it reproduced the disease. The variety "bitamisi" appears to be very resistant to this disease. A description of the causal bacterium, compiled with the assistance of Mr. W. J. Dowson, is appended:—

##### *Bacterium cassavae*, Hansford.

Leaf spots dark green and watersoaked, especially on the lower surface of the leaf; usually 1 to 2 mm. in diameter and angular in outline; older spots become confluent and are often arranged in irregular lines along the

\* *Cylindrosporium sesami*, Hansford, sp. nov.

Maculae 2-5 mm., brunneae, irregulares vel rotundatae, plerumque zonatae, saepe angulatae et confluentes.

Hyphae conidiophorae amphigenae, plerumque epiphyllae, dense aggregatae brevissimae, 8-14×3-4 $\mu$ ; stroma usque 50 $\mu$  diam., olivacea.

Conidia longa filiforma, 3-6-septata, haud constricta, leniter attenuata, hyalina, 140-200 $\mu$  longa, ad basim 3-4 $\mu$  lata et rotundata.

Hab. in folia *Sesami indici*, Bukalasa, Uganda, Hansford 1861.



main veins of the leaf. In many cases they occur around the edges of the spots caused by *Cercospora cassavae*, E. and Ev. In late stages when the leaf begins to turn yellow prior to being shed, the dark green colour of the younger bacterial lesions persists and they become more prominent than before. Old lesions turn dark brown in colour and partially dry out.

The stem lesions occur on the younger branches and are often associated with the leaf bases; no evidence of their origin in a manner similar to the stem lesions caused by *B. malvacearum* on cotton has been obtained. The lesions are dark green and watersoaked, later turning brown, and are frequently covered with a thin layer of yellow-brown exudate or gum, consisting of bacteria and a yellow gummy substance produced by the infected tissues of the plant. As a rule the lesions are limited to one side of the stem, but on very susceptible varieties of cassava complete ringing at the point of infection may occur, being followed by the death of the distal parts of the plant. The bacteria in most lesions are limited to cortical tissues, though on occasion they may spread through the wood and invade the pith. No vascular spread through the wood occurs and the bacteria do not spread in the inner tissues beyond the limits of the external lesions.

In culture the bacteria form very short rods with a few peritrichiate flagella; no capsules, no spores; Gram-negative and not alcohol or acid fast. Agar colonies are rounded, smooth, lens-shaped with entire edges, translucent and of uniform structure, yellow. Gelatine is slowly liquefied and the bacterium is a facultative anaerobe. It grows well in broth forming a ring and a yellowish precipitate in old cultures. Nitrates are rapidly reduced; milk is rendered alkaline but not cleared. Acids, but no gas, are produced in dextrose, sucrose, maltose and glycerin, but not in lactose.

Hitherto the distribution of this disease outside Bukalasa has not been worked out except that a few lesions have been found at Serere on one variety of cassava.

The Wilt disease of Cassava due to *Verticillium dahliae* has been described above in connection with Cotton Wilt. The fungus penetrates to all parts of infected plants including the tubers, in which a dry rot occurs.

#### SUGAR CANE.

The Mosaic disease had been found to affect P.O.J.2822; the infected plants suffer somewhat severely from the attack and it was recommended that this variety be abandoned in Uganda.

A dry rot of the base of canes was caused by *Marasmius* sp. The disease was limited to individual stools scattered through the fields and appeared to commence its attack on the underground stem. No explanation of the distribution of this disease could be found and stools next to those infected remained quite healthy. As a rule most of the canes in a diseased stool are killed. At present the disease cannot be considered as important in its effect on the crop, though both P.O.J.2725 and P.O.J.2878 have been found infected. The disease corresponds to the "acute" form of *Marasmius* root disease described by Nowell in the West Indies. The more usual and widespread attack of *Marasmius sacchari* in the West Indies results in gradual deterioration of whole fields of sugar-cane and this form of the disease has not been found in Uganda to date.

#### BEANS.

A bacterial disease of beans was discovered at Bukalasa during the year and cultures isolated from affected leaves correspond to descriptions of

*Bacterium phaseoli*, which causes Bacterial Blight of Beans. Affected plants showed small watersoaked leafspots.

#### CASSIA SIAMEA.

A stem disease of this tree was found at Serere; trees, three to four years old, showed a rot of the bark, which became sunken and dark in colour and eventually dried out and split, exposing the wood underneath, which was attacked by insects. The disease commences its attack at the base of small lateral shoots or larger branches. From the diseased bark only a species of *Fusarium* (section *Martiella*) was isolated.

#### TEPHROSIA CANDIDA.

A scab disease of this cover crop was found at Kampala; affected plants show minute lesions on leaves, petioles, branches and inflorescence at first almost white but later raised and corky. This disease is due to *Elsinoe tephrosiae*\* and by itself causes no important damage to the plant. The lesions on the branches and main stem, however, are invaded by a number of other fungi and bacteria, including forms of *Cladosporium herbarum* and *Fusarium*. The latter cause a rot of the bark around the original lesion, and spread to the wood of the branch, which is killed. Attack on the main stem is followed by death of the whole plant.

*Fusarium* diseases of *Cajanus cajan* and of *Crotalaria juncea* were also investigated during the year; from the former host a number of different *Fusaria* were isolated, including *Hypomyces ipomoeae*, *Lisea* sp. and *Gibberella* spp. Affected pigeon pea plants die off from the top downwards and although inoculations have not given positive results it is suspected that the *Gibberella* spp. are the primary parasites and that the other *Fusaria* are secondary invaders of the diseased tissues. The disease is distinct from the wilt of this crop reported from India.

The *Fusarium* disease of Sunn Hemp bears more resemblance to a typical wilt; affected plants dry up and shed their leaves, at first often only on one side of the plant. In later stages the base of the plant is covered with a pink to buff layer of spores of *Fusarium scirpi* and occasionally another *Fusarium* with a *Gibberella* stage is also present.

The common leafspot disease of *Hibiscus rosae-sinensis* has been identified as due to *Bacterium hibisci*; a different bacterium, not yet identified, has been isolated from a rot of the fruits of *Hibiscus esculentus*.

In conclusion I have to thank the staff of the Imperial Mycological Institute and of the Royal Botanic Gardens Herbarium, Kew, for identification and assistance in the work of collecting Uganda parasitic fungi, which has been carried on in the intervals of other work. A host list of these fungi has been prepared for publication in the *East African Agricultural Journal*. Mr. W. J. Dowson of the Botany School, Cambridge, has kindly assisted in the determinations of cultures of bacteria.

C. G. HANSFORD,  
*Plant Pathologist.*

\* *Elsinoe tephrosiae*, Hansford, sp. nov.

Ascomata plus minusve sparsa, pulvinata, brunnea, ellipitica v. linearia, usque 1 mm., longa, rarius ad 3 mm.; epithecium pseudoparenchymaticum; asci sub epithecio in regione stromatica pallidiore dispositi, globosi vel sub-globosi, 18-23 $\mu$  diam.; ascospori hyalini, oblongo-elliptici, 13-15  $\times$  6-7 $\mu$ , 3-4-septati, ad septum medium constricti, parte superiore crassiore et brevior, parte inferiore tenuiore et longiore, longitudinaliter 1-septati; episporium tenue.

Hab. in foliis et ramis *Tephrosiae candidae*, Kampala, Uganda, Hansford 1904.

## ANNUAL REPORT OF THE CHEMICAL SECTION.

The Senior Chemist was stationed at Serere throughout the period under review, studying conditions relating to soil erosion and degeneration. During February and March he toured the Karamoja District with the Director of Geological Survey and the Conservator of Forests in the same connection.

The Chemist was absent on home leave until December 15th and work on the laboratory side was much reduced.

## Laboratory.

The following is a summary of work carried out in the Laboratory during the year:—

|                                                 |    |    |    |    |    |     |
|-------------------------------------------------|----|----|----|----|----|-----|
| Reaction                                        | .. | .. | .. | .. | .. | 372 |
| Moisture at Sticky point                        | .. | .. | .. | .. | .. | 360 |
| Loss on ignition                                | .. | .. | .. | .. | .. | 360 |
| Organic carbon                                  | .. | .. | .. | .. | .. | 292 |
| Nitrogen                                        | .. | .. | .. | .. | .. | 478 |
| Available Nutrients:—                           |    |    |    |    |    |     |
| Nitrates—phosphate                              | .. | .. | .. | .. | .. | 101 |
| potash                                          | .. | .. | .. | .. | .. | 224 |
| calcium                                         | .. | .. | .. | .. | .. | 215 |
| Native foodstuffs—complete analysis             | .. | .. | .. | .. | .. | 13  |
| do do (Moisture, Protein, Fibre, Ether extract, |    |    |    |    |    |     |
| carbohydrate, ash                               | .. | .. | .. | .. | .. | 11  |
| Composts                                        | .. | .. | .. | .. | .. | 4   |

## A. Erosion and Regeneration.

The soil erosion and fertility experiments mentioned in last year's report have been described in detail in the *East African Agricultural Journal*\*. Since that description was prepared for publication the erosion experiment has been changed in one detail. Rats and/or natives broke down the sweet potato bunds in search of food, and *Harrisonia*, an indigenous thorn, has been substituted. The following are the anti-erosion treatments therefore:—

- (a) Lemon grass contour hedges.
- (b) Contour bunds with *Harrisonia*.
- (c) Contour strips of uncultivated land.
- (d) Natural terracing by piling up cleared trash.
- (e) Control—no treatment.

Each anti-erosion treatment is being tried on ploughed and on uncultivated land, the whole experiment consisting of ten treatments per block replicated five times. The plots are 44 yards long (down the slope) by 11 yards wide, the anti-erosion treatments occupying contour strips 1 yard wide. For yield records each plot is harvested in three portions each 41' × 33', the intermediate strips on the control plots being discarded.

\* March, 1937, Vol. II, No. 5, pp. 371–378.



Cotton (S.P.84) was sown in June, 1936, but the plants made very little headway at first, particularly on those blocks which had been occupied by *Amomum* species. About midseason, however, the crop improved in appearance and picking began in November and continued through to the end of January. Bulo was sown into the standing cotton on February 5th, 1937. There was an immense variation in yield within plots of this experiment, the lowest being 4.82 and the highest 36.83 lbs. There were no significant differences within blocks but between blocks the differences were very significant. The block totals reading from the top of the slope were 376, 390, 685, 641 and 683 lbs. This may be accounted for partly by the presence of *Amomum* in the top blocks and partly by the fact that the hill must already have suffered erosion although closely covered by short grass and mixed bush. The poor start made in the area in which *Amomum* was dominant was undoubtedly due to nitrogen starvation brought about by turning under comparatively large quantities of vegetable matter of low nitrogen status within a short time of planting the cotton. The stunting and yellowing was characteristic and a similar effect had already been reported by Hosking\*.

The fertility experiment will remain as described in the *East African Agricultural Journal* except that, if possible, the resting covers on Rotations 7 to 12 will be grazed and not lopped to simulate grazing. Observations have shown that under no conditions does lopping have the same effect as grazing.

The first two blocks of Cycle I were sown to cotton (S.P.20) in June. Picking was started in November and continued into January. Bulo was sown on the fourth of February and had begun to germinate by the eighth. Plot yields here, too, varied enormously, the extreme difference being between 7.5 lbs. and 22.35 lbs. The soil analyses have not yet been completed but as far as can be seen the deciding factor has not been the nutrient status of the soil. When all the analytical figures in this work are complete the whole series will be analysed statistically before changing the line of attack on the problem of the relation of soil conditions to crop production.

In addition to the Serere experiments on erosion and soil deterioration the team of workers drawn from all Departments in Teso has concentrated on the prison farms. These farms started in the first instance as a result of the co-operation of the Agricultural Officer (Teso) and the Administration in an effort to make each prison self-supporting in respect of food supply. After consulting the Medical Officer to obtain an idea of a suitable diet for the prisoners, a rotation was planned to include those crops needed for food, plus one cash crop (cotton) to provide a fund for buying spares for implements, etc. At the same time provision has been made for an adequate resting period under grass. As these farms are situated at the County headquarters their distribution is ideal for extension work in farming methods. Each farm is provided with a covered kraal to house 25 head of cattle and for the time being the manure is being stored under the hoof. At first the warders were taught composting but the product consisted largely of soil and it was clear that they could not be expected to carry out this operation without much closer supervision. Composting was therefore deleted from the programme until a more simple method has been evolved. If the bulk of manure under hoof becomes too great it will be removed to covered stores outside the kraal until required. The fields on these farms are seven acres in extent and each

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\* Hosking, H. R., *E, A, J.*, Vol. II, pp. 313-314.

sloping field will be contour banded. At the same time work is in progress to find cattle-proof growing hedges so that the resting land may be used for controlled grazing.

The experimental work in Teso aims at establishing an intensive system of agriculture in place of the present extensive system known as shifting cultivation. The Serere experiments should answer the problems of minimum rest, the best type of resting cover, the best anti-erosion measures and the effect of manuring. The small holdings and prison farms in addition to supplying very valuable information on these points also, should be as well admirable foci for the dissemination of knowledge in the district. The change over from extensive to intensive agriculture will, of course, be very gradual as it would be folly to pursue propaganda and the extension work until the new system is backed by results. In the meantime the areas which are hopelessly over-populated must be dealt with and it is proposed to survey the district in order to demarcate the over-populated and under-populated areas as a preliminary to encouraging the movement of people from the former to the latter. Movements to and from balanced areas will be discouraged.

The lack of population in some areas is closely linked up with the availability of water supplies and these areas will be examined in this connection.

The success or failure of the attempts to establish intensive agricultural methods coupled with effective anti-erosion measures is closely linked with land tenure. The main reason why our efforts, to induce the farmer to adopt even the simplest anti-erosion measures in the past (outside Buganda), have produced so poor a result is that the peasant farmer will not put in the extra work necessary on land to which he has no secure title. With no security of tenure the peasant farmer is directly encouraged to be a land-robber. Whatever the results of our experiments little progress in the direction of intelligent conservative farming methods can be expected until a solution to the problem of land rights has been found.

In addition to the direct attack on the problem in Teso District, the Director of Geological Survey and the Conservator of Forests are engaged on a survey of the problem of soil erosion and water supplies in the Protectorate as a whole. The Senior Chemist was privileged to accompany them on a six-week safari in Karamoja on this work. In addition to making the examination of a large number of soil profiles possible this safari was extremely helpful in demonstrating the extreme phases of erosion which follow the cultivation of land on the slightest slope in the semi-arid areas of parts of Karamoja.

The problem of Karamoja is really one with the Teso problem in its broader sense of climate. Experiments at Kampala and the work of Hosking at Serere have shown that cotton yields (and presumably those of the food crops) are closely correlated with rainfall distribution. It follows, therefore, that any efforts to protect the natural vegetation of Karamoja and the demarcation of a forest boundary belt between Karamoja and Teso are likely to affect the rainfall distribution in, and therefore the crop producing power of, this district.

### **B. Farmyard Manure.**

Any change over from an extensive to an intensive agricultural system must be accompanied by the use of manures. The experiments on the manufacture and storage of farmyard manure reported last year have been continued.

TABLE I.  
ANALYSES OF KRAAL MANURE FROM SERERE.

| Sample.                                                             | Moisture | Determined on oven-dried sample. |          |            |            |
|---------------------------------------------------------------------|----------|----------------------------------|----------|------------|------------|
|                                                                     |          | Loss on Ignition                 | Carbon % | Nitrogen % | C/N ratio. |
| Kraal No. 2—Stored under hoof*                                      | 56.1     | 68.5                             | 22.4     | 1.50       | 14.9       |
| Kraal No. 1—Stored under hoof 1 year                                | 65.1     | 47.0                             | 17.9     | 1.17       | 15.3       |
| Kraal No. 1—Stored under hoof 1 year and uncovered outside 2 months | 63.0     | 30.0                             | 10.7     | 0.56       | 19.1       |

\* No. 2 Plantation herd received concentrates for part of the year.

The figures show that manure made by bedding up the cattle continuously in covered kraals is extremely valuable. Making allowance for moisture, the manure from the concentrate-fed cattle is as good as that from cake-fed cattle at home.

The table also brings out the remarkable loss of nitrogen brought about during even a short period of exposure. It is clear that the manure should be carted from the kraal direct to the land and ploughed in. Cattle should not be bedded too liberally or the rise in floor level may make double carting necessary. Alternatively the roof and entrance must be made higher to compensate for floor rise. If double carting is unavoidable the manure should be stored under cover, when under aerobic conditions a gain in nitrogen might be anticipated, as shown by the Bukalasa figures last year.

### C. Composts.

Composting was continued at Serere during the year but although the analytical figures show some improvement the extra labour involved in the making and distribution of compost would not justify its recommendation to the peasant farmer. Two typical analyses are given in Table II.

TABLE II.  
ANALYSES OF COMPOST FROM SERERE.

| Sample.                       | Moisture | Determined on the oven-dried sample. |          |            |            |
|-------------------------------|----------|--------------------------------------|----------|------------|------------|
|                               |          | Loss on Ignition                     | Carbon % | Nitrogen % | C/N ratio. |
| 45 days .. .. .               | 57.6     | 37.0                                 | 11.2     | 0.77       | 14.6       |
| 90 days .. .. .               | 65.0     | 20.2                                 | 9.5      | 0.62       | 15.3       |
| Indore mean of 12 heaps .. .. | ..       | ..                                   | ..       | 0.896      | 12.86      |

### D. Cotton Seed.

In our report for last year attention was drawn to the immense loss of nutrients entailed by the export (and destruction by fire) of cotton seed. There is little progress to report during the year under review except that experiments have begun to assess the value of cotton seed and cotton seed meal as fertilizers. At the same time the co-operation of home authorities has been sought to test the value of cotton seed oil as diesel and as direct firing fuel.



Until the results of all this work are available it is not known what steps can be taken to retain the seed (or meal) in the country and to restore it to the soil which produced it.

### E. Cotton Soils.

#### WILT.

In connection with the investigation of the incidence of Wilt disease at Bukalasa, soil samples were drawn for analysis from highly infected and slightly infected plots with the following results:—

TABLE III.

SOIL DATA ON WILT AFFECTED AND UNAFFECTED PARTS OF THE MAIN INCREASE BLOCK AT BUKALASA.

|                      |       |    |    |    | % Organic Matter. | Available Nutrients %.        |                  |      |
|----------------------|-------|----|----|----|-------------------|-------------------------------|------------------|------|
|                      |       |    |    |    |                   | P <sub>2</sub> O <sub>5</sub> | K <sub>2</sub> O | CaO  |
| <b>"Good Sites"—</b> |       |    |    |    |                   |                               |                  |      |
| I                    | 0-8"  | .. | .. | .. | 5.65              | .0021                         | .070             | .391 |
|                      | 8-16" | .. | .. | .. | 1.79              | .0016                         | .027             | .163 |
| II                   | 0-8"  | .. | .. | .. | 5.88              | .0096                         | .110             | .562 |
|                      | 8-16" | .. | .. | .. | 1.90              | .0016                         | .076             | .210 |
| <b>"Bad Sites"—</b>  |       |    |    |    |                   |                               |                  |      |
| I                    | 0-8"  | .. | .. | .. | 5.38              | .0055                         | .065             | .497 |
|                      | 8-16" | .. | .. | .. | 2.05              | .0018                         | .042             | .201 |
| II                   | 0-8"  | .. | .. | .. | 5.93              | .0100                         | .117             | .583 |
|                      | 8-16" | .. | .. | .. | 3.59              | .0037                         | .088             | .368 |

It will be seen that there is no indication that the incidence of Wilt follows any of the soil constituents determined. Work on Wilt disease of cotton in India\* has given indications that heavy dressings of farmyard manure will reduce the incidence of Wilt. It may be mentioned that local native opinion holds that Wilt does most damage on richer soils and general observation over two seasons tends to support this view.

### F. Tea Soils.

During the year the detailed examination of the soil samples drawn from the new tea experiment site in Toro (Kyembogo) was concluded. The area had been contour surveyed by Mr. W. J. Mill Irving, Agricultural Officer, Toro District, and soil samples taken from pits along a traverse from hill to swamp. These samples were analysed and the soil was found to be well supplied with available nutrients. In one place, however, a calcareous layer at a depth of 3 feet was found and near old hut and kraal sites the soil was undoubtedly too alkaline for tea. A comprehensive reaction survey of the whole area was then made, on which recommendations for siting the tea and coffee experimental work were based.

### G. Native Foodstuffs.

A start has been made on what is intended to be a comprehensive survey of native foodstuffs. Table V (see page 56) gives the results obtained to date and whilst these are too limited in scope for a detailed discussion there are some points of interest which arise.

\* D. Kulkarni, *Ind. Journ. Agric. Sci.* 4, pp. 976-1047. Studies on Wilt Disease of Cotton in Bombay Presidency.

There is, for example, considerable variation among varieties of the same food. The variety Gonja is distinctive among the plantains as is Kiwoko among the Sweet Potatoes. The differences are due to a lower water content in each case but if this is a property of the variety it is important.

The high protein contents of maize and rice are noteworthy. Both maize meal and rice flour were bought in the Kampala Market.

There is no indication of mineral deficiency in any of the foods examined, all of them being on a level in respect of mineral content with similar foods whose analyses have been reported from elsewhere.

The authors of a recent Bulletin\* suggest mineral deficiency as a possible contributory cause of disease in a part of Teso. No foods have as yet been submitted for analysis from that district but this point will receive attention later.

The high ash content of the maize flour, bought in Kampala Market, is remarkable and would appear to suggest adulteration. This possibility is being investigated.

Analyses of the skins of sweet potatoes and bananas and of pods of mpindi have been made. These are given in Table III.

TABLE IV.

|                    |    | Moisture. | Ash. | Constituents of Ash.          |                  |       |
|--------------------|----|-----------|------|-------------------------------|------------------|-------|
|                    |    |           |      | P <sub>2</sub> O <sub>5</sub> | K <sub>2</sub> O | CaO   |
| Banana Skins       | .. | 84.5      | 1.17 | 0.011                         | 0.63             | Trace |
| Sweet Potato Skins | .. | 71.7      | ..   | 0.014                         | 0.61             | 0.004 |
| Mpindi Pods        | .. | 84.8      | ..   | 0.052                         | 0.25             | 0.019 |

On three varieties of plantains the proportion of food to total weight averaged 50 per cent.

### General.

Chapters on Soils, Soil Erosion, and Manures were contributed to the *Review of Agriculture* which is shortly to be published, together with some notes on Shifting Cultivation.

W. S. MARTIN, *Senior Chemist.*

G. ap GRIFFITH,\* *Chemist.*

\* *An Investigation into Health and Agriculture in Teso, Uganda.* By Messrs. Ireland, M. G. de C., Hosking, H. R., and Loewenthal, Dr. L. J. A.

TABLE V.

| Food.                                     | Moisture<br>% total. | Protein. | Ether<br>Extract. | Fibre. | Soluble<br>carbo-<br>hydrates. | Ash. | Ash constituents.             |                  |       |
|-------------------------------------------|----------------------|----------|-------------------|--------|--------------------------------|------|-------------------------------|------------------|-------|
|                                           |                      |          |                   |        |                                |      | P <sub>2</sub> O <sub>5</sub> | K <sub>2</sub> O | CaO   |
| <i>Plantains</i> —                        |                      |          |                   |        |                                |      |                               |                  |       |
| Gonja ..                                  | 57.5                 | 1.39     | 0.11              | 0.37   | 39.05                          | 0.59 | 0.075                         | 0.45             | 0.012 |
| Nakabuluta ..                             | 76.1                 | 1.40     | 0.09              | 0.29   | 21.47                          | 0.65 | 0.064                         | 0.48             | 0.017 |
| Nakitembe ..                              | 77.3                 | 1.44     | 0.07              | 0.23   | 20.23                          | 0.73 | 0.058                         | 0.39             | 0.011 |
| <i>Sweet Potatoes</i> —                   |                      |          |                   |        |                                |      |                               |                  |       |
| Kiwoko ..                                 | 60.8                 | 1.76     | 0.15              | 0.83   | 35.68                          | 0.78 | 0.14                          | 0.47             | 0.053 |
| Kawungezi ..                              | 65.6                 | 0.97     | 0.10              | 0.74   | 31.62                          | 0.97 | 0.17                          | 0.53             | 0.044 |
| Kisabo ..                                 | 66.7                 | 1.17     | 0.20              | 0.70   | 30.46                          | 0.77 | 0.14                          | 0.45             | 0.035 |
| Kigezi (variety not stated)               | 67.8                 | 0.97     | 0.31              | 1.18   | 28.5                           | 1.2  | 0.083                         | 0.31             | ..    |
| Manabali (Bufumbira)                      | 64.3                 | 0.96     | 0.14              | 0.91   | 32.8                           | 0.9  | 0.076                         | 0.23             | ..    |
| Ntega (Kigezi) ..                         | 69.7                 | 1.34     | 0.16              | 0.85   | 27.0                           | 0.9  | 0.071                         | 0.25             | ..    |
| <i>Beans</i> —                            |                      |          |                   |        |                                |      |                               |                  |       |
| Mutike (Fresh) ..                         | 61.1                 | 9.90     | 0.65              | 1.91   | 24.69                          | 1.55 | 0.095                         | 0.67             | 0.088 |
| " (Dry) ..                                | 8.0                  | 20.90    | 2.22              | 5.95   | 59.5                           | 3.40 | ..                            | ..               | ..    |
| Buyindiindi ..                            | 62.3                 | 9.27     | 9.52              | 2.45   | ..                             | ..   | ..                            | ..               | ..    |
| Bangonyu (Kigezi)                         | 14.6                 | 23.2     | 1.08              | 5.34   | ..                             | ..   | ..                            | ..               | ..    |
| <i>Peas</i> —                             |                      |          |                   |        |                                |      |                               |                  |       |
| Mpindi (Cowpeas)                          | 68.8                 | 9.18     | 0.64              | 1.93   | 18.03                          | 1.42 | 0.083                         | 0.61             | 0.039 |
| Mitale (Kigezi) ..                        | 13.6                 | 26.3     | 1.18              | 5.48   | 50.7                           | 2.6  | ..                            | ..               | ..    |
| <i>Maize</i> —                            |                      |          |                   |        |                                |      |                               |                  |       |
| Maize Meal ..                             | 11.5                 | 10.60    | 3.59              | 1.85   | 61.0                           | 11.5 | ..                            | ..               | ..    |
| Mtigakasa (Kigezi)                        | 13.3                 | 10.2     | 3.50              | 1.96   | 69.5                           | 1.5  | ..                            | ..               | ..    |
| <i>Rice</i> —Flour ..                     | 11.0                 | 8.50     | 0.27              | 0.32   | ..                             | ..   | ..                            | ..               | ..    |
| <i>Cassava</i> —(average of 17 varieties) | 12.9                 | 1.72     | ..                | 2.25   | ..                             | 1.55 | ..                            | ..               | ..    |
| Sesere ..                                 | 69.7                 | 1.28     | 0.20              | 1.11   | 5.9                            | 1.80 | 0.082                         | 0.67             | 0.048 |
| Anani ..                                  | 62.4                 | 1.46     | 0.21              | 0.92   | 33.6                           | 1.4  | 0.078                         | 0.51             | 0.075 |
| <i>Eleusine</i> (Wimbi)—Bufumbira         | 14.7                 | 8.7      | 1.02              | 5.20   | 67.8                           | 2.6  | ..                            | ..               | ..    |
| <i>Eleusine</i> (Wimbi)—(Kigezi)          | 14.4                 | 7.82     | 1.07              | 3.48   | 68.9                           | 4.3  | ..                            | ..               | ..    |
| <i>Sorghum</i> (Mtama)—Kigezi             | 13.9                 | 9.50     | 3.12              | 2.62   | 68.0                           | 2.4  | ..                            | ..               | ..    |

N.B.—Except where specifically stated, the foodstuffs were purchased in or near Kampala.



## REPORT OF THE BOTANICAL SECTION FOR THE YEAR ENDED 30th JUNE, 1937.

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### (i) BOTANICAL WORK, KAMPALA.

The Botanist, in addition to the botanical work at Kampala, carried on the supervision of the Kampala Plantation and the Botanic Gardens, Entebbe. The more important results of experiments on the Kampala Plantation have been embodied in this report and that of the Senior Chemist; and therefore no separate report on the plantation has been written.

### Meteorology.

2. The total rainfall for the year on the Kampala Plantation was 55.44 inches, a figure 6 inches above the average; the excess of rain fell during the early part of the year—January and February, which are usually dry months, were relatively cool and damp. In fact, the dry spell was so little marked that the coffee flowering was seriously affected—scarcely a single flower of Arabica coffee opened in February and March, which are the normal months of flowering. May was unusually dry—the rainfall was nearly 3 inches below the average, June was very wet. There was a marked drought during July, August and part of September; the rainfall at the end of the year was approximately normal and conditions were quite good for planting.

### Coffee.

#### A. SELECTION AND BREEDING.

3. *Selection*.—No new selections were made on native farms during the year, but most of the trees previously selected were visited and further notes were made on their condition and crop. A visit was paid to the Masaka District in March to inspect the selections in that neighbourhood; and many of the trees in Kyagwe and Kyadondo were inspected later in the year. On the whole, the crops during 1936 were light; it was expected that this would be the case, for most of the trees bore heavily in 1935 and, as mentioned in previous reports, there is a marked tendency towards biennial cropping.

4. The only new selections that were numbered were seven of the most promising trees in the progeny rows laid down by Mr. Liebenberg on Plot 4, Kampala Plantation; eight tentative selections had been made in 1934 and seven of them were considered to be worthy of being tested further. Unfortunately, a series of different types of pruning has been tried on the plot (as mentioned in paragraph 13 below) and, in consequence, it is very difficult to assess the relative value of the trees, for their growth and cropping have been seriously altered by the treatments that they have received.

5. *Planting at Kawanda*.—The most important work in connection with Robusta coffee during the year was the raising of desirable types of coffee for planting at Kawanda, the site of the new laboratories; owing to the projected abandonment of the Kampala Plantation, it has been necessary to raise seedlings of all the more important types of coffee growing there in

order that they may be represented on the new estate, together with the progeny of the new selections. Planting at Kawanda was commenced in 1935, when progeny rows of seventeen spreading ("Nganda") and seven erect ("Robusta") selections were planted. The growth at first was rather slow, and much labour has been entailed in replanting blanks, for there were many failures in the original planting. By the end of 1936, the trees were large enough for pruning and training to commence; the permanent trees of both "Nganda" and "Robusta" types were bent over in order to stimulate the production of branches: the former are to be trained as spreading trees and the latter are to be pruned on the "Agobiada" system, with a succession of new upright branches from the base. The temporary trees of both types (inter-planted diagonally between the permanent trees) were pruned on the single stem system: it appears that it will be difficult to train "Nganda" trees in this way, for they sucker profusely. By the beginning of 1937 there were marked differences between the appearance of the two types of coffee—the "Robusta" had made much more vigorous growth with longer primaries and much larger leaves than the "Nganda". This disparity, in part, may be due to the fact that the former are growing on fairly good, almost level soil, while the latter are on a slope which has suffered from erosion; but there is no doubt that genetical characters are largely responsible. Evidence is accumulating that rapid early growth and precocious fruiting have a very bad effect on Robusta coffee in Uganda, and it will be interesting to compare the condition of the two types at Kawanda after some years and to see whether the spreading trees with their slower growth may not prove, in the long run, to be of more value than those of the erect types which, at present, have a better appearance.

The influence of pruning also is very marked at Kawanda, especially among the "Nganda" coffee trees: the permanent trees have been bent over and about five branches on each tree have been tied outwards with banana fibre to sticks in order that a very spreading habit may be produced; on such trees there is little crop. The temporary trees, trained on the single stem system, however, are bearing a considerable amount of fruit and, in consequence, it is probable that next year their growth will be severely checked.

6. Owing to uncertainty concerning the layout of the estate, no planting could be done at Kawanda during 1936, and the various progenies were grown on in the nurseries at Kampala; these seedlings were cut back and planted as "stumps" in April, 1937, the land having been cleared, lined out and holed by the Plantation Manager. Firstly, a block of progeny rows of twelve more "Nganda" selections—Nos. 202, 204, 242, 245, 247, 248, 249, 250, 251, 254, 255, 256—was planted, there being forty permanent trees of each selection at a spacing of 15 feet  $\times$  15 feet with a temporary tree in the centre of each square. Secondly, there was a block of fifteen progenies—each containing fifty permanent trees—at a spacing of 12 feet  $\times$  12 feet, with a temporary tree in the centre of each square; in this block there are progenies obtained by self-pollination of selections Nos. 1, 2, 3 and 4; No. 243, an outstanding erect tree in the Masaka District; Nos. 257, 258, 259, 260, 261, 262, 263, which are reselections from Mr. Liebenberg's progeny rows on Plot 4, Kampala Plantation—these were all raised from selfed seed and, in addition, there are progeny rows from open pollination of Nos. 257, 258, 259, for it is desired to compare the effects of open and of self-pollination on the variability of a progeny.

Progenies of various Java selections were also planted—fifty of 72.01; twenty-five of B.S.109; fifteen of S.A.24; six of Ngredog and two of 124.09;

it is hoped that these plants will grow, although they were very large for planting, having been raised from seed introduced in 1934.

7. In addition, on the north side of the main blocks of coffee, narrow strips were measured out and on them were planted short rows of various interesting types. A collection of wild Robusta coffee included progenies from eleven forests in various localities—Itwara and Kibale (Toro); Bwamba; Kasai and Mukono (Kyagwe); Kalisizo and Namirenbe (Masaka); Busoga; Lotti, Thallanga and Laboni (Sudan). A collection of Arabica coffee varieties comprised Mokka; San Ramon; Padang; Nyasaland; Blue Mountain; Kent's; Kenya Series A; wild Abyssinian (two types differentiated by the shape of their seeds). Other *Coffea* species were planted, including *C. excelsa*; *C. liberica*; *C. congensis*, *C. eugenioides*; and a few rooted cuttings of Arabica and Robusta coffee were put out. Spaces were left for other types of coffee, of which seedlings are being raised for planting in 1938; these types include more Java selections, which have been self-pollinated; more wild Robusta types—from the Budongo Forest (Bunyoro) and the Zoka Forest (Gulu); *C. arabica* var. *Maragogipe*; and some of the hybrid coffees on the Kampala Plantation—such coffees are of little commercial importance on account of their low fertility, but it is possible that more productive types may arise in later generations.

8. When these other coffees have been planted, the collection at Kawanda will include a wide range of forms. The main blocks of Nganda types, already planted, include progeny rows of twenty-nine spreading trees selected from Kyagwe, Kyadondo, Sese and Buddu and should afford valuable material on which to commence breeding; as they cover six acres, they should supply seed sufficient to meet all the demands which at present cannot be satisfied. There are also blocks, covering four acres, which include progenies of Java selections, eight erect selections made locally and the seven reselections from Plot 4, Kampala Plantation (some of which appear to be of 'Nganda' types). The short observation rows of wild Robusta coffee, of Arabica types and *Coffea* species occupy about one acre, making a total of about eleven acres.

9. *Self-pollination*.—In order to raise progenies for planting at Kawanda, several branches of trees of Java selections (Nos. 59/01, 105/03, 83) were bagged and self-pollinated during the first half of the year 1936. The flowering was sporadic, for there was no well marked dry season at the beginning of the year; actual counts of the flowers could not be made, as they opened so irregularly. Only a very few of the flowers produced fruits and hardly any of the fruits contained more than one seed. The very small proportion of success is in agreement with the results reported from self-fertilisation of Robusta coffee in the Dutch East Indies and is in contrast to the much higher proportion obtained here in previous years by the self-pollination of local types. It is hoped to make further investigations into self-fertilisation of Robusta coffee in Uganda, for the problem has a great bearing on the work of breeding; if there can be found strains which are highly self-fertile, the segregation of relatively pure types may be facilitated.

10. *Investigation into Size of Beans*.—The progeny rows of various 'Nganda' selections, which were planted at Mukono in May, 1934, by the Senior Agricultural Officer, produced a considerable crop at the end of 1936. The assertion that 'Nganda' coffee trees are excessively slow in coming into bearing therefore does not appear to have any foundation although, as mentioned in paragraph 5 above, they do not seem to be so precocious as some of the erect "Robusta" types. In September, samples of one hundred cherries were picked



from all the trees which were bearing ripe fruit, the beans were extracted, dried and weighed, giving the following results:—

| Mother Tree |    |                                |     | Number of Progeny fruiting. | Average weights of beans of progeny (grams). |          |       |
|-------------|----|--------------------------------|-----|-----------------------------|----------------------------------------------|----------|-------|
| Number.     |    | Average weight of bean (gram). |     |                             | Lowest.                                      | Highest. | Mean. |
| 208         | .. | ..                             | ·16 | 6                           | ·13                                          | ·19      | ·16   |
| 213         | .. | ..                             | ·18 | 12                          | ·12                                          | ·20      | ·15   |
| 214         | .. | ..                             | ·17 | 12                          | ·14                                          | ·22      | ·16   |
| 215         | .. | ..                             | ·16 | 5                           | ·13                                          | ·19      | ·16   |
| 222         | .. | ..                             | ·14 | 8                           | ·15                                          | ·21      | ·17   |
| 223         | .. | ..                             | ·18 | 4                           | ·13                                          | ·17      | ·15   |
| 233         | .. | ..                             | ·19 | 5                           | ·14                                          | ·18      | ·16   |
| 234         | .. | ..                             | ·17 | 5                           | ·12                                          | ·18      | ·14   |
| 236         | .. | ..                             | ·17 | 8                           | ·13                                          | ·17      | ·15   |
| 239         | .. | ..                             | ·13 | 10                          | ·12                                          | ·23      | ·16   |

On the whole, the size of the beans therefore was well above that of native Robusta coffee—in a typical sample of which the average bean weight was ·11 g.; it is true that these figures from Mukono refer to the maiden crop which often yields a bolder sample than is produced subsequently but, on the other hand, many beans had been damaged by *Stephanoderes* attack.

The bean size of various Java Robusta selections (of erect types) growing on the Kampala Plantation were also investigated at the end of the year, and the results were:—

| Selection. |    |    |    | Number of Progeny examined. | Average weights of beans of progeny (in grams). |          |       |
|------------|----|----|----|-----------------------------|-------------------------------------------------|----------|-------|
|            |    |    |    |                             | Lowest.                                         | Highest. | Mean. |
| 94         | .. | .. | .. | 19                          | ·12                                             | ·21      | ·18   |
| 24         | .. | .. | .. | 20                          | ·11                                             | ·23      | ·16   |
| 56         | .. | .. | .. | 20                          | ·10                                             | ·19      | ·14   |
| 1          | .. | .. | .. | 19                          | ·13                                             | ·21      | ·16   |
| 105/03     | .. | .. | .. | 7                           | ·13                                             | ·21      | ·17   |
| 83         | .. | .. | .. | 14                          | ·10                                             | ·22      | ·16   |
| 59/01      | .. | .. | .. | 3                           | ·16                                             | ·20      | ·19   |

These Java selections were all young trees, bearing their first or second crops, and therefore the Nganda progenies at Mukono may justifiably be compared with them. While there were few Nganda trees whose beans were so large as those of some of the Java selections, yet their average size was only slightly less, and they showed less variation—a very desirable feature in a sample of coffee.

## B. VEGETATIVE PROPAGATION.

11. Trials extending over the last few years have shown that a fair proportion of rooting may be expected from large woody cuttings, inserted in the nursery beds and kept shaded and watered. A few such cuttings, planted at Kampala in 1935, made quite good growth in 1936 although, when young, they did not grow so rapidly as seedlings. A single Arabica cutting appeared to suffer more from drought than did Robusta cuttings, but its growth was better than that of grafted Arabica coffee trees growing on the same plot. It is probable that the Robusta cuttings would in time form good trees; for it

appears that many of the fine old specimens throughout the countryside were grown from cuttings—the common method of propagation by the natives of Uganda before the advent of Europeans. Another batch of rooted cuttings of both Arabica and Robusta coffee has been planted at Kawanda.

### C. EXPERIMENTS.

12. *Soil Treatment and Plant Growth Experiment*.—The fortnightly measurements of the trees on these plots, described in former reports, were stopped because there was no chemist stationed at Kampala to supervise the concurrent fortnightly examination of the soil on the plots. The various treatments, however, are being continued and, before the Kampala Plantation is given up, it is hoped to make a final examination of the root distribution and to correlate it with the effect of the various treatments on the soil. Temperature records were kept as before and, in December, two Rogers soil moisture meters (vacuum gauge type) were put in position—one on the clean weeded plot and one on the mulched plot. At first, when the soil was uniformly wet, the readings on the two gauges were in close agreement; then, during the dry season, the pressure deficiency rose much more rapidly on the clean weeded than on the mulched plot—this result was expected, for it is obvious that mulching greatly depresses that rate at which the soil dries. With the advent of rain, both readings fell but, although the soil on both plots has been saturated with water, the readings on the gauge of the clean weeded plot have not fallen so low as at the commencement of the experiment. It appears, therefore, that further trials and adjustments of the instruments will be needed before they furnish accurate figures.

13. *Robusta Coffee Pruning Experiment* (Plot No. 4, Kampala Plantation).—This experiment was described in the previous annual report; the yields until the end of 1936 have been:—

| Method of pruning.             | Average yields (in ozs. of fresh cherry per tree). |      |        |
|--------------------------------|----------------------------------------------------|------|--------|
|                                | 1932-35                                            | 1936 | Total. |
| Single stem .. .. .            | 498                                                | 231  | 729    |
| Agobiada .. .. .               | 690                                                | 283  | 973    |
| Multiple stem .. .. .          | 597                                                | 292  | 889    |
| Modified multiple stem .. .. . | 545                                                | 271  | 816    |
| Free multiple stem .. .. .     | 586                                                | 256  | 842    |
| "Kinawa" .. .. .               | 598                                                | 266  | 864    |

The total yields from the Agobiada system continue to be superior to any of the others and it is obvious that it is the most suitable method of pruning Robusta coffee at the close spacing (8 feet × 8 feet) on the plot; the Single stem system is unsuited to Robusta coffee—if it is continued, all the lower primaries die off and an umbrella shaped tree results with a bare stem and spreading drooping branches; while there is not space for the proper development of the large spreading trees which should be formed by the Multiple stem and "Kinawa" systems. There was scarcely any flowering on the Arabica coffee pruning experiment (Plot 3, Kampala Plantation) and, as the trees on some subplots were defoliated by a sudden infestation by caterpillars (*Metadrepana marantica*) in May, it was considered advisable to strip the crop, which was a very small one.

14. *The Hygroscopic Properties of Coffee*.—It had been noticed that there were often considerable variations in the weights of small samples of coffee

which were being examined in the course of selection and breeding; and therefore some observations on the hygroscopic properties of coffee beans were undertaken. The process of drying coffee was not continuous—much of the moisture lost during a day might be regained during the succeeding night; it would be advisable, therefore, that coffee should be kept not merely under cover but, if possible, in a closed dry place at night. When the coffee had been dried, the percentage of moisture in the bean at Kampala fluctuated about a mean figure of 11.3%—this figure applied to both Robusta and Arabica coffee, whether sun-dried or fermented. The dried pericarp, however, under normal conditions contained considerably more water—about 13% in Robusta and 16.5% in Arabica; owing to the more pulpy nature of Arabica coffee, a longer period is required to prepare it by sun-drying than is needed for Robusta coffee. When the Arabica “buni” (sun-dried cherry) is exposed to moist air, the pericarp takes up water more rapidly than does Robusta “buni”; in both species the absorption of water by the bean is much slower than by the pericarp. A short article on this subject was prepared for publication in the *East African Agricultural Journal*.

#### D. ARABICA COFFEE.

15. *The Influence of Soil Acidity on the Growth of Coffee*.—During the course of a safari in June through the West Nile District it was noticed that the coffee at Payida, growing on soil that was approximately neutral in reaction, had made stronger, less compact growth than that in other places where the soils were definitely acid. It was suggested later that the soils in many parts of the west of Uganda were too acid to be ideal for the growth of Arabica coffee. In August a safari was made to the Kigezi District to report on the Arabica coffee there, especially in view of the damage done by *Antestia* in some places. The infestation is most marked in the north of the district where the soils are definitely acid, while in Bufumbira County, where the soils are of volcanic origin and are less acid, there have been no *Antestia* attacks. It was suggested, therefore, that there might be some correlation between soil acidity and *Antestia* damage, just as in Nyasaland the white stem borer appears to be most prevalent on coffee growing in poor soils with an acid reaction (*Annual Report of Department of Agriculture, Nyasaland, 1933*, p. 10). Even when no insects were present, the growth of the coffee appeared to be influenced by the soil; for example, the trees near Kabale on acid soils were stunted and suffered from “hot and cold” disease, while those on volcanic soils in Bufumbira at the same altitudes had a much stronger, more open, habit. Trials of the effects of shade were advised, and of top dressing with wood ashes, the usual practice on native coffee plots in Ruanda: not only would the ashes render the soil less acid, but also they would increase the supply of potash to the trees, a factor which sometimes is of great importance in coffee cultivation (*Annual Report of Hawaii Agricultural Experiment Station, 1936*, p. 44). A detailed study of the problem is now being undertaken by the Chemist, Kampala.

#### Tea.

16. *Dr. Weddige's Visit*.—Most of July was spent in conducting Dr. L. W. Weddige, who came from Tanganyika to advise concerning the tea industry of Uganda, around the main tea growing areas of the country—Kyagwe, Singo, Toro and Buddu.

17. *Variety and Pruning Trial*.—One and a quarter maunds of seed, purchased from India, of each of the four jats—Dangri, Dhonjan, Betjan, Rajghur—were received in December. Most of the seed was forwarded



immediately to Kawanda and Kyembogo (Toro) where it was sown in nursery beds in order to provide seedlings for the variety and pruning trials to be laid down on those plantations. A small extra quantity of seed was forwarded to Toro, which will be used for planting segregated seed gardens near Butiti. Small amounts of Dhonjan and Betjan were sown in the Botanic Gardens to provide seedlings for filling in the blanks of the plots at Kitabi and Entebbe; while seedlings of Dangri and Rajghur are being raised at Kampala and it is hoped to lay down segregated plots of them in the neighbourhood. The germination of the imported seed was excellent, but local seed of the two jats—Dahootea Assam (from Kampala) and Kalline Manipuri (from Buwunga)—which are to be included in the trials, grew very badly and further supplies were sent to Kawanda and Kyembogo. Investigations of the percentage of “floaters” and the germinating capacity of the seed from the Kampala plot are in progress.

### Fixed Oil Plants.

18. *Oil Palm*.—The routine recording of the old oil palm plot at Entebbe (planted by the Forestry Department in 1921) was continued but, as those palms were raised seed of the wild palms in the Semliki Valley, which are known to be of a poor type, it is probable that they will be of little value for breeding work. The more recently introduced types show much more promise: some of the progeny of Calabar selections, planted at Entebbe in 1934, have ripened their first bunches of fruit within three years after planting; the individual fruits, however, as yet are very small and poorly developed. Seedlings are being raised from the best of the Malay oil palm progeny at Kampala and land is being drained at Entebbe in order that the palm plot there may be extended in 1938.

19. *Castor Seed*.—The work of selection of this crop was continued; progeny rows, each of sixteen plants, at a spacing of 10 feet  $\times$  10 feet, were sown at the end of March with seed from fifteen selections of the 1935–36 crop on the plantation, together with a row of various types grown in the Sudan. Germination was irregular and the blanks had to be filled once or twice. On the whole, the yields were good; none of the Sudan types produced so much seed as the Kampala selections. The fruits from each plant were picked separately until April, 1937, when harvesting was discontinued and the yields were weighed in order that selection of the types to be sown in the current year might be made.

20. *Aleurites moluccana*.—It is very improbable that either of the two species—*Aleurites montana* and *A. fordii*—whose seeds furnish tung oil, will ever be of any economic importance in Uganda, for their growth is very stunted. The Candlenut, *Aleurites moluccana* (*A. triloba*), however, grows rapidly and fruits abundantly at Kampala and Entebbe; samples of the nuts were sent to the Imperial Institute to ascertain whether they would be of any value for export.

The report stated:—

“Candlenuts consist of about 66 per cent. of a hard, woody shell and about 34 per cent. of an oily kernel. The kernels contain normally from 62 to 67 per cent. of oil, which is pale yellow and liquid at ordinary temperatures. The oil belongs to the “drying” class of vegetable fatty oils and may be used in the manufacture of paint . . . . Even on the assumption that the oil could be disposed at a figure somewhat below the price of linseed oil,

the export of the undecorticated nuts would not be remunerative and could not be recommended, on account of the high proportion of shell present. The decortication of candlenuts, however, presents special difficulties and in spite of various attempts it does not appear that any machine has yet been devised that can satisfactorily replace the hand methods used in the Philippines . . . . On the assumption that candlenut oil could be disposed of at a figure somewhat below the price of linseed oil, the kernels would not be worth more than £15 per ton in London. . . . From the foregoing information it will be seen that the exploitation of *Aleurites moluccana* in Uganda cannot be recommended at the present time."

### Essential Oil Plants.

21. Little work was done on these plants during the year: stocks were maintained and the propagation of *Pelargonium radula* (two varieties) was continued.

### Spices and Condiments.

22. A small plot of Japanese Chillies was planted at Kampala and selection was continued. The Vanilla, planted on a plot of *Gliricidia sepium*, made fairly good progress although it was checked by severe infestation of mealy bug on the *Gliricidia*; towards the end of the year, however, the trees became much more healthy as the channel of the Kitante bordering the plot was deepened by the Township Authority and the drainage was greatly improved. In December a Wardian case was received from the Royal Botanic Gardens, Peradeniya, Ceylon, and among the plants it contained were Allspice (*Pimenta officinalis*), "Bay Tree" (*Pimenta acris*) and Nutmeg (*Myristica fragrans*); in March, 1937, they were added to the collection of spice and drug plants in the Botanic Gardens, Entebbe.

### Drugs and Insecticides.

23. *Hydnocarpus*.—The *Hydnocarpus wightiana* on the Kampala Plantation has grown into spreading, multi-stemmed small trees; many plants are weighted down with the crops of fruit. A report has been received\* on the samples of seeds sent from the Botanic Gardens, Entebbe, in 1935, stating that:—

"It will be seen that the oil from the 1935 sample of seeds from Uganda meets the requirements of the British Pharmacopoeia with the exception that the saponification value is just below the permitted minimum"; oil from a sample sent in 1932 was stated to differ considerably from the standards of the Pharmacopoeia.

The *Hydnocarpus anthelmintica* trees on the plantation have made tall fastigiate growth and, up to the present, there has been a very small production of fruit at Kampala.

A sample from the trees at Entebbe, sent in 1935, received the following report:—

"The oil of *Hydnocarpus anthelmintica* kernels is not recognised in the British Pharmacopoeia, but it is in common use in Siam. . . . The oil from the Uganda seed differs considerably from the Siamese oil, having higher specific gravity, specific rotation and iodine number but a lower saponification value".

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\* From the Secretary of the British Empire Leprosy Relief Association.

24. *Tephrosia Vogelii*.—This native shrub is used as a cover crop on the Kampala Plantation, for which purpose it is well suited, lasting for about three years, although occasional plants are killed by disease (*Elsinoe* sp.). As the leaves are known to contain tephrosin, which has strong insecticidal properties, samples of dried leaves from Kampala and from Toro were forwarded to the Imperial Institute to discover whether they would be of economic value. The report stated that there was no rapid method of estimating tephrosin and that the leaves were being forwarded to Rothamsted for direct insecticidal trials.

### Fibres.

25. *Abroma augusta*.—The plot of two acres sown at the end of 1935 contained many blanks, for the germination was very poor; during 1936, whenever the weather was suitable, these spaces were resown and replanted with seedlings from the nursery beds—it was found that the best results were obtained with seedlings about a foot high, cut back to six inches before planting; by the end of the year a good stand was obtained. The growth of the *Abroma*, however, was very disappointing, for it suffered badly from attacks of Wilt disease (*Verticillium* sp.): many shoots were stunted and died back from the tips. In consequence, when harvesting and retting of all the stems which were sufficiently mature (that is, those on which about one third of the flowers had opened) was carried out the yields were very poor and by the end of 1936 only 210 pounds of prepared fibre were ready. No difficulty was experienced with the retting: in most cases the process was complete in about seven days but for some of the more mature stems a longer period was needed. During the current rainy season the growth has been much stronger and it is hoped that a large bulk of fibre may be prepared before the end of 1937.

26. *Manila Hemp (Musa textilis)*.—The plants are suckering profusely and making large stools but the pseudo-stems are not tall—very few are more than nine or ten feet high, much shorter than the *Musa bakeri* which was grown formerly under the name of *Musa textilis*.

### Sugar Cane.

27. The recently introduced selections were propagated at the beginning of the year until there was a whole plot of each. Towards the end of the year more planting material of the most promising of the varieties was distributed to local sugar estates; a total of  $8\frac{1}{2}$  tons of cane was sent out.

### Green Manures and Legumes.

28. A large range of pulse and green manure crops is grown on the plantation and a few additions were made during the year, notably Tepary Bean from Bukalasa, and Coco Rose Cranberry Bean, Chick Pea and Lentil from the East African Trade Commissioner, London; the Chick Pea and Lentil produced very little seed. Selection was continued on Sunn Hemp: progeny rows of the 1936 selections were sown in March and twenty plants were selected in July, just before the seed ripened.

### Grasses.

29. The collection of grasses on the Kampala Plantation was replanted on more level ground in November; the plots were rearranged in order that all the species of a genus might be together and a few additions were made.



The following species are now included in the collection:—

|                                        |                                  |
|----------------------------------------|----------------------------------|
| <i>Axonopus compressus.</i>            | <i>Panicum atrosanguineum.</i>   |
| <i>Beckeropsis uniseta.</i>            | do <i>maximum.</i>               |
| <i>Brachiaria brizantha.</i>           | do <i>trichocladum.</i>          |
| do <i>decumbens.</i>                   | <i>Paspalum auriculatum.</i>     |
| do <i>platynota.</i>                   | do <i>commersonii.</i>           |
| do <i>soluta.</i>                      | do <i>conjugatum.</i>            |
| <i>Cynodon dactylon</i> vars.          | do <i>dilatatum.</i>             |
| do <i>plectostachyum</i> vars.         | <i>Pennisetum clandestinum.</i>  |
| do <i>transvaalensis.</i>              | do <i>polystachyon.</i>          |
| <i>Chloris gayana.</i>                 | do <i>rupellii.</i>              |
| do <i>pynothrix.</i>                   | <i>Rhynchelytrum repens.</i>     |
| do <i>virgata</i> var. <i>elegans.</i> | <i>Setaria aequalis.</i>         |
| <i>Digitaria velutina.</i>             | do <i>chevalierii.</i>           |
| <i>Eragrostis mildbraedii.</i>         | do <i>sphacelata</i> vars.       |
| <i>Hyparrhenia cymbaria.</i>           | <i>Sorghum verticilliflorum.</i> |
| do <i>filipendula.</i>                 | <i>Sporobolus pyramidalis.</i>   |
| do <i>rufa.</i>                        | do <i>filipes.</i>               |
| do <i>ruprechtii.</i>                  | <i>Themeda triandra.</i>         |
| <i>Melinis mailandii.</i>              | <i>Trichopteryx kagerensis.</i>  |
| <i>Exothea abyssinica.</i>             |                                  |

There is a great range of forms to be found in many species of tropical grasses, and selection of the more useful types has been commenced in some instances. For example, most of the strains of *Cynodon dactylon* in Uganda are coarse and relatively short lived when mown to form lawns; but a compact variety from the Scott Laboratories, Nairobi, shows promise of being more permanent and seedlings of it are being raised to ascertain if they may not be even better than the parent. One of the main desiderata of a pasture grass is a spreading habit; the forms of *Setaria sphacelata* common in Buganda make erect tufts, but a type from Ngetta, with well developed rhizomes, has a spreading habit and therefore is being used for breeding. New grasses are frequently added to the collection, especially those which are of potential value for pastures.

Cuttings of *Tripsacum laxum* (Guatemala Grass) forwarded from the Imperial College of Tropical Agriculture, Trinidad, arrived in good condition but, although carefully planted and watered, none of them grew; it was hoped that might be a useful fodder grass in the districts which are too hot and dry for Elephant Grass (*Pennisetum purpureum*).

### Fruits.

30. *Citrus*.—It has become evident that Sour Orange and Pomelo stocks will be of little use for the propagation of most types of *Citrus* in Uganda, for the conditions of the trees on this stock became worse and worse—even those which had made a little growth at first were quite useless for planting out. Many of those budded on Rough Lemon stock grew well, and several agricultural stations were supplied with different trees on this stock, which will be used exclusively in the present year. A certain amount of *Citrus* budding was carried out in April and May but, owing to the absence of a Plantation Manager, not much could be done afterwards.

31. The fruit plot on the Kampala Plantation was enlarged and one or two more species planted there. In December, some new types of fruit were imported in a Wardian case from Ceylon, including *Durio zibethinus* (Durian), *Artocarpus communis* (Breadfruit) and *Nephelium lappaceum* (Rambutan); unfortunately, only the latter species survived to be planted at Entebbe. Several healthy Durian seedlings, however, have been raised from seed supplied from the Botanic Gardens, Singapore.

### Papers.

32. An article on "The Oil Palm in Uganda" was published in the *East African Agricultural Journal*. During the latter part of the year most of the time was spent in preparing several sections for the Review of Agriculture, a lengthy process necessitating the perusal of many old reports and files.

### Introductions.

33. Successful introductions of plants of economic importance included:—

*Bromelia pinguin* from the Atkins Institution, Cuba.

Pulses and *Caesalpinia spinosa* (Tara Bean) from the East African Trade Commissioner, London.

*Aegle marmelos* (Bael Fruit) from the Horticultural Section, Giza, Egypt.

*Durio zibethinus* (Durian) from the Botanical Gardens, Singapore.

*Myristica fragrans* (Nutmeg), *Pimenta officinalis* (Allspice), *P. acris* (Bay Tree) and *Nephelium lappaceum* (Rambutan) from Royal Botanic Gardens, Peradeniya, Ceylon.

The kindness of all those who have generously supplied these plants is gratefully acknowledged.

A. S. THOMAS, *Botanist*.

## (ii) ANNUAL REPORT ON THE BOTANIC GARDENS, ENTEBBE, FOR 1936.

During the year under review the supervision afforded for the Gardens varied but little from that of the past few years—a weekly visit from Kampala by the Plantation Manager plus an occasional visit by the Botanist.

### Meteorology.

2. The past year was one of the wetter years with a total of 73·85 inches of rain. Its distribution was good apart from April and June which were very wet months with 16·43 and 13·23 inches respectively. The highest fall of the year occurred during the former month, on the 18th, 4·20 inches being registered on that day.

There were 179 days during the year on which rain was recorded.

*Temperatures*.—The Mean Maximum was 77·8°F, the Mean Minimum 59·8°F. Both are very close to those of the previous year.

The highest temperature of the year, 84·0°F, was recorded on August 18th, the lowest, 57·2°F, on January 12th.

We are indebted to the Officer-in-Charge of the local station of the British East African Meteorological Service for the above figures which have been taken from the monthly summaries kindly supplied.

### Labour.

3. An ample supply of unskilled labour was available throughout the year. On an average between 75–80 men were employed each month.

Wages paid were Sh. 11 at commencement, increasing to Sh. 13 after several months of regular service.

### Oil Palms (*Elaeis guineensis*).

4. Recording of yields from the original plot was continued as hitherto, there being an average of 30 palms in bearing each month.

A total of 11,438 lbs. of fresh fruits was collected during the year.

The new area of Nigerian palms planted during 1934 made continued progress and with but one or two exceptions produced flowers at some time during the year and at the end of December a few palms were even carrying bunches of well developed fruits.

A small amount of new development is in progress, the clearing of a corner adjoining the palm plot at the far end to accommodate palms from a Malay strain.

### Hydnocarpus Species.

5. *Hydnocarpus wightiana*.—This species was very prolific during the year and maintained steady growth.

*H. anthelmintica*.—Practically the reverse has to be said about this as it is only where the soil is better than any appreciable headway is noticeable. No tree in bearing was anything like so prolific as those of *H. wightiana*.

### Pepper (*Piper nigrum*).

6. The vines with but few exceptions have continued to flower freely, and have made considerable growth.

No fruits have yet been formed.

### Tea (*Thea sinensis*).

7. Trees which eventually survived at Entebbe have made good growth as a whole, those at Kitabi less so. Towards the end of the year the more forward of the Bet-jan variety at Entebbe were producing fruits, while the Dhon-jan at Kitabi had only commenced to flower.

Seed of both varieties has recently been imported from India to fill the many gaps.

### Coffee.

8. *C. robusta*.—Single rows of twelve strains are now established, all from various Uganda forests.

The two types planted out during the previous year have grown well, and have recently produced a small flush of flowers.

*C. arabica* vars.—At the far end of the plot space has been allocated for a collection of arabica varieties, and a single row of each of ten varieties from seed originating from neighbouring territories has been planted to date.

All appear to have established themselves well.

It might be of interest to record that this was said at first of both Kent's and Harar. These, since then, have been most disappointing, as both have been subject to leaf disease (*Cercospora coffeicola*), Harar being the worst affected of the two. In some cases plants were entirely defoliated by the disease.

### Fruit.

9. The imported budded Citrus have done very badly.

There was one addition to the collection during the year, three plants of *Feijoa Sellowiana*.

Plants of *Telfaira pedata* from seeds introduced during 1934 fruited during the year.



### Nursery.

10. This suffered considerably early in the year from storm damage. One very violent storm was experienced on April 19th. This brought down a fine specimen of *Piptadenia Buchanani* just outside the nursery, smashing one plant-house and the contents of two beds between.

Heavy rains at this time caused numerous old springs to rise with the result that several beds were completely submerged for a period of from five to six weeks. Many plants died in consequence and one or two species were all but lost.

Fifty yards or so higher up from the nursery a whole block of Conifers, several years old, was uprooted. Other parts of the Gardens fared better but a good deal of damage was done to specimen trees either by the snapping off of trunks or branches, or upheaving them.

The "Mauritius Thorn" hedge around the outside of the nursery was replaced by one of "Kei apple" during the year, the former having not made much headway and having become infested with a species of waxy scale.

### 11. Distribution of Plants and Seeds.

|            |    |    | Plants. | Seeds.     | Clumps. |
|------------|----|----|---------|------------|---------|
| Economic   | .. | .. | 2,262   | 20 packets | 1       |
| Decorative | .. | .. | 2,801   | 48 packets | 11      |

One European estate was supplied with 3 lbs. 5 ozs. of Quinine seed by special request, and the Agricultural Officers at Serere and Lira were furnished with various budded Citrus trees, 36 and 12 respectively.

### Lawns and Flower Beds.

12. The former were maintained at the usual standard, it being only at times when the rains were continuous that the grass in places became untidy.

Additional areas put down to grass during the year were the slope between the Para block and the Lake, with Aloes on the one side and native plants on the other, and that previously containing Conifers.

Most of the existing flower beds were kept going, one exception being those near the fernery containing roses. Cannas were substituted here in a new lay-out and did very well considering the fertility of the soil, thus brightening what was previously one of the dull parts of the Gardens.

Nearer the nursery two long wide borders and a pergola were created, both being partly planted up before the end of the year.

### Roads and Drains.

13. A good deal of attention was again given to both in some form or other, and several alterations and improvements effected within the lower levels of the Gardens.

In the fernery several drains were rebuilt, and a new channel made to carry away the water from the spring.

Above the oil palm plot, the building of a long and fairly deep drain was well advanced at the end of the year with a view to tapping numerous springs which arise in this vicinity.

Two new lengths of roads were opened for general use, one looping round from the Para Block overlooking the lake and out at the far end of the Para, the other passing near the top of the fernery, through the palms, and out near the top of the hill near the Cassia collection. This in a few years' time should be a favourite with visitors as it will be one of the few roads in the Gardens with a fair amount of shade.

From this a lead off through the fernery was made.

### Labelling of Plants.

14. This work was continued at intervals and at the end of the year nearly eight hundred plants and trees had been labelled under a new system with Xylonite labels.

A good deal, however, still remains to be done before all the species in the Gardens are dealt with accordingly.

### Introductions.

15. Ninety-four species and varieties were received during the year. These came in chiefly as seeds and were mainly from plants of a decorative character.

A consignment of plants which came from the Royal Botanic Gardens, Ceylon, unfortunately did not travel at all well, several were dead on arrival, and a few others died almost immediately afterwards.

### Entebbe Flower Show.

16. This was held in the Entebbe Club on May 24th, 1936. It was marred to some extent by the heavy rains a short time beforehand.

An exhibit was staged on similar lines to those of previous years, plants less commonly grown in Uganda being the chief feature, and a number of plants were provided for prizes.

### Acknowledgments.

17. Grateful thanks are expressed to officials in charge of various establishments, and to all other persons who kindly responded to our requests for either seeds or plants during the year.

P. CHANDLER, *Plantation Manager.*

## (iii) BOTANICAL WORK, BUKALASA.

### Meteorological.

The climate of the 1936/37 season was abnormal except in so far as the planting months were concerned. May and June were normal, in fact June had more rain than the average. July was very dry indeed—so dry that cotton planting was impossible. This dry period is normal and is a very excellent reason in itself for early planting. It is nearly always impossible at Bukalasa to plant cotton between 10th and 31st July which means that cotton sown after the end of June has nearly always to be sown in August and September when a considerable drop in yield occurs. In practice, in Buganda, it is impossible to plant all the crop early because cotton so often follows the food-crops such as groundnuts, sim-sim, etc., except in newly

opened land. The food crops cannot be removed until they are ripe and cotton cannot be planted until they have been harvested. The Muganda cultivator is frequently criticised for uprooting his cotton early but unless he does this, and he seldom loses much crop by doing so, he is unable to get his all important food crops planted early. If these are not put in early he may miss the critical rains and he will certainly have to plant the following cotton crop very late.

Abnormal weather was experienced in the period October to mid-December when less than half the average rain fell with the result that the development of the plants was very slow. Plenty of flowering took place and the first crop was a full one. Owing, however, to the lack of plant scaffolding no second crop could be laid down and the crop finished at an earlier date than it has ever done before at Bukalasa. From the middle of December flowering practically ceased until the middle of February when a small flush occurred too late to produce a second crop. January and early February were dry so that the main picking peak, which occurred in January, was cleaner than usual; in fact the percentage of stained cotton was lower than has been previously recorded at Bukalasa.

The effect of the dry weather was to cause some premature boll opening with the consequent production of immature lint. The staple was short due to the same cause and most varieties dropped a millimetre in length this season.

TABLE I.

| Month.       | Total Rainfall. | Deviation from 14 years mean. | Highest Fall. ins. | Number of Days on which rain fell. | Mean Daily Sunshine Hours. |
|--------------|-----------------|-------------------------------|--------------------|------------------------------------|----------------------------|
| <b>1936.</b> |                 |                               |                    |                                    |                            |
| March ..     | 4.64            | -0.31                         | 0.90               | 14                                 | 6.6                        |
| April ..     | 9.75            | +2.98                         | 2.09               | 19                                 | 5.2                        |
| May ..       | 3.47            | -1.43                         | 1.39               | 10                                 | 6.3                        |
| June ..      | 6.17            | +2.58                         | 1.72               | 17                                 | 5.5                        |
| July ..      | 1.11            | -2.40                         | 0.35               | 13                                 | 5.7                        |
| August ..    | 3.79            | -1.26                         | 1.80               | 12                                 | 6.2                        |
| September .. | 5.40            | +0.25                         | 1.12               | 16                                 | 5.9                        |
| October ..   | 2.36            | -4.89                         | 1.45               | 10                                 | 6.4                        |
| November ..  | 1.82            | -2.56                         | 0.74               | 6                                  | 6.4                        |
| December ..  | 6.32            | +3.13                         | 1.48               | 16                                 | 5.0                        |
| <b>1937.</b> |                 |                               |                    |                                    |                            |
| January ..   | 0.75            | -0.82                         | 0.33               | 6                                  | 7.1                        |
| February ..  | 4.21            | +1.97                         | 2.75               | 7                                  | 5.4                        |
| March ..     | 5.91            | +0.98                         | 1.85               | 12                                 | 5.8                        |

Hail only occurred once—in September—and fortunately only slight damage resulted.

### Breeding Plot.

*New Selection Series.*—Very nearly half of this Series consisted of single plant selections made in B.P.50 for freedom from Wilt. None of these showed any sign of resistance but two in particular, B.344 and B.345, showed remarkable recovery from the disease and despite almost complete defoliation produced a good crop. The ginning outturn was rather low and staple on the weak side on these recovered plants and the disease doubtless affects the maturity of the lint hairs.



Of the other new selections, B.181 families were the most promising as the plants have a very good erect habit, and are highly resistant to Blackarm; indications were present of resistance to Wilt; they yielded well but unfortunately the lint was rather short. Further efforts to isolate long linted strains will be made and in the meantime sufficient seed will be bulked next season to obtain a sample of lint for spinning reports. B.180 families were very peculiar, being unlike anything else selected out of local. They were very tall, late maturing and resistant to Blackarm. The lint was long but ginning outturn rather low. It is unlikely that this group will be of any economic value in itself but it is being used in the crossing programme on account of its Blackarm resistance. The B.274 group, which has the most erect habit of any of our cottons, did comparatively well but it was still susceptible to Blackarm and its yield was comparatively low. The lint on the other hand, was very fine indeed and further work is being done on this group.

No U.4's showed any promise and B.147/21, a suspected U.4, was very heavily infected with Blackarm.

Several single plant selections which had been made by Makerere students promised well except that they showed no evidence of being resistant to Blackarm.

#### *Characters of the Most Promising Strains.*

| Strains.          | Ginning percentage. | Lint Length. mm. | Blackarm Lesions per plant. | Bolls per plant. |
|-------------------|---------------------|------------------|-----------------------------|------------------|
| B.180. 3.15 .. .. | 28.2                | 30.0             | 0.06                        | 32.0             |
| B 181.12. 3 .. .. | 32.4                | 28.5             | 0.00                        | 38.0             |
| B.181.12.15 .. .. | 33.0                | 29.1             | 0.20                        | 31.2             |
| B.274.19.18 .. .. | 31.1                | 31.2             | 1.06                        | 26.0             |

#### **Pedigree Lines.**

The following groups formed the bulk of the lines—B.P.52, B.P.79, U.4, and S.G.23/8. The B.P.52 group consisted for the most part of bulks from B.P.116 and B.P.119, selected for Blackarm resistance. In general the incidence of Blackarm in these pedigrees was high on individual plants and it is possible that the groups are still splitting for Blackarm resistance. Lint length and ginning percentages were above standard and practically no Wilt occurred. In point of fact very little Wilt occurred anywhere in the Pedigree Line block, probably due to the absence of infected soil.

The S.G.23/8 group was disappointing in so far as the isolation of a longer linted type was concerned. Naked seeded pedigrees isolated from S.G.23/8 have given harsh lint and low ginning percentages and they have been discarded. Some improvement in resistance to Blackarm has been obtained but only at the expense of staple length. Despite dozens of selections made from S.G.23/8 it has been found impossible to obtain a single strain giving any improvement over the original parent, except for B.P.104 which is superior in most characters and is definitely more uniform as it has been evolved by annual single plant selection for a period of 9 years—its full pedigree being (S.G.23/8 6, 13. 7. 10. A7. B.16. A.11). Further selection with B.P.104 is unlikely to be fruitful as it has reached a stabilised condition.

The U.4 group consisted of 2 lots—one lot originating from U.4.4.2 and the other from U.4/130 (from S. Rhodesia) *via* U.B.24/4. The necessity for a long

silky U.4 type is well known and U.4/130 derivatives appear to meet it. The U.4.4.2 lines showed no increase in length over the parents and were susceptible to Blackarm. All have been abandoned. The U.4/130 lines which have come *via* U.B.24/4 produced fair crops, long and silky lint with good ginning outturns although these latter were lower than the general run of U.4's. Blackarm was fairly severe and further reselection will be necessary to improve the group in this respect. As regards lint characters the U.4/130's are slightly superior to S.P.84, the Serere strain from U.4.4.2, but they are probably lower yielders and certainly more susceptible to Blackarm. In the B.P.79 group (Reselections from B.P.50) nothing outstanding was obtained. The habit of growth was typical, *i.e.*, erect and storm resistant with long pointed bolls. Blackarm was fair in most of them and no improvement on B.P.50 has been made.

The following table summarises the characters of some of the most important Pedigrees.

| Group and Origin.                        | Pedigree. | Blackarm<br>Lesions<br>per plant. | Bolls<br>per plant. | % Bolls<br>shed. | Lint<br>Length.<br>mm. | Ginning<br>percentage. |
|------------------------------------------|-----------|-----------------------------------|---------------------|------------------|------------------------|------------------------|
| B.P.52 ..<br>(N.3/5 Nyasaland<br>Upland, | B.P.116   | 1.22                              | 26                  | 54               | 30.6                   | 31.2                   |
|                                          | B.P.119.1 | 2.10                              | 29                  | 50               | 30.9                   | 31.8                   |
| S.G.23/8<br>(Nyasaland<br>Upland,        | B.P.149   | 0.81                              | 26                  | 54               | 28.7                   | 34.8                   |
|                                          | B.P.150   | 0.39                              | 29                  | 49               | 28.3                   | 32.7                   |
| U.4.4.2 ..                               | B.P.140.1 | 3.20                              | 23                  | 54               | ..                     | ..                     |
| U.B.24/4<br>(U.4/130)                    | B.P.141   | 1.30                              | 24                  | 55               | 30.7                   | 34.8                   |
|                                          | B.P.142   | 1.25                              | 27                  | 47               | 30.0                   | 32.2                   |
|                                          | B.P.143   | 1.00                              | 22                  | 52               | 29.8                   | 32.3                   |
| B.P.79 ..<br>(B.P.50,<br>B.37 Local)     | B.P.155   | 2.27                              | 20                  | 52               | 31.4                   | 31.3                   |
|                                          | B.P.158   | 1.06                              | 19                  | 62               | 30.9                   | 31.1                   |
|                                          | B.P.162   | 1.50                              | 20                  | 57               | 29.9                   | 30.6                   |
|                                          | B.P.165   | 0.75                              | 25                  | 46               | 30.4                   | 32.4                   |

It will be noted that the boll shedding rates are low. The flowering rates are also low, the average production of flowers per plant being about 50, and over 90% of them opened in October and November.

### Improvement in Lint Characters.

The increasing predominance of short stapled plants in Buganda cotton has become such an urgent problem that all possible methods of increasing staple length are being tried. The obvious and only really satisfactory solution to the problem is the production of a pure line; this, however, takes a long period as so many other characters have to be taken into account, *e.g.*, disease resistance, earliness and habit of growth. To obtain a pure line combining all these characters is a lengthy process and is probably unattainable. On the other hand a line pure for one or even two characters is dangerous as it may break down completely owing to the absence of some resistance factor. The reason for the high and uniform yield of Buganda cotton is undoubtedly due, in the main, to the fact that being in a highly heterogeneous state the plants

do not all react in the same way to adverse climatic conditions, diseases and insect pests. This provides food for thought and the question arises as to the desirability of using a heterogeneous population instead of a homogeneous one. If a satisfactory heterogeneous population can be built up by mixing strains of known history it may be possible to insure against failure of the crop due to any one or two adverse factors.

This form of controlled mixing is being investigated at Bukalasa but it is too early to give any results from the investigation. It is essential to use comparatively closely related strains and those having as far as possible similar lint characters. It is difficult to predict what will happen, and as the constitution of the population will change every season owing to intercrossing, it will be some time before the mixture becomes stable and before any definite evidence of success or failure can be forthcoming.

Use is being made of Mass selection as a possible temporary measure. This season, a plot of Local Buganda cotton was grown and rigid selection for Blackarm resistance, earliness and lint length was done, the last character being taken as the most important. At the end of the season less than 15% of the original plants remained—these all having lint lengths of 30 millimetres or over. Seed taken was self fertilised and a careful test of the bulk will be made in the next season.

It is satisfactory indeed to record that B.P.52 has done so well in spinning tests carried out in India and England. It is still too early to be certain that this variety will replace local but present evidence indicates that it will do so. This variety is a comparatively pure strain originating from a single plant selected in N.3/5 cotton (Nyasaland Upland) by Stephens at Bukalasa in 1929.

### Increase Plots.

Three  $\frac{1}{4}$ -acres were planted at Bukalasa, Kawanda and Kampala. That at Bukalasa was planted with U.B.24/4, a promising selection from U.4/130 originating in Southern Rhodesia. This strain is characterised by a much longer and silkier lint than the normal run of U.4 derivatives, but unfortunately this is correlated with a comparatively high susceptibility to Blackarm. A yield of 410 lbs. per acre was satisfactory under the circumstances.

The quarter acres at Kawanda and Kampala were bulk mixtures and neither showed any promise, yields being low and Wilt and Blackarm prevalent.

The Medium Bulk Increase Plot of  $1\frac{1}{2}$  acres was planted with B.P.52. It yielded over 1,000 lbs. seed cotton per acre and ginned out at 31.4% commercial ginning. This variety will be put through the remaining stages of increase as rapidly as possible as its lint characters are very definitely superior to those of Local Buganda. It is interesting to note that B.P.52 is the first Nyasaland Upland derivative to do well in Buganda.

*Main Increase—18 acres.*—This area was under the mixture X, *i.e.*, a mixture of S.C.23/8, B.P.52 and Local. The idea underlying these mixtures is explained under "Improvement of Lint Characters". The yield was higher than has been recorded previously from this plot, the average over the whole area being 507 lbs. per acre. As 50% of the cotton was late sown and as the plot has been under cultivation for at least five years this yield is very satisfactory. 4,623 lbs. were ginned at Ngogwe and gave a ginning percentage of 30.84 which was surprisingly low.



### Seed Farm Area.

The purchase by Government of 700 acres at Kawanda, to form a cotton seed farm as an adjunct to Kawanda Experiment Station, was completed this year. Under the present arrangement the tenants are allowed to stay on the land and they will grow our cotton. A survey of the cotton acreage revealed an area planted in 1936/37 of 124 acres.

In order to bring the area up to a minimum of 200 acres use will have to be made of the segregated area surrounding the new land. This area is naturally segregated by swamps so that any natural crossing with the local variety is almost impossible. The area under cotton there was 105 acres so that the two areas combined provide just over the minimum requirements.

### Segregated Area.

Further searches were made for a suitable Segregated Area to be the stage next after Kawanda Seed Farm. The Entebbe peninsular project was abandoned for the time being as being unlikely to provide a stable acreage.

The most suitable area found was that comprising the Gombolola of Mumyuka and Musale of Bugerere County. The whole of Mumyuka and the southern part of Musale are naturally segregated by river, swamp, and forest and the acreage under cotton is well within the limits that can be supplied from Kawanda. Every plot of cotton was measured in this area and the total acreage was 1,393 with a taxpaying population of 1,062. The comparatively low area per taxpayer is due to cultivators finding the production of plantains for sale in Kampala more lucrative than cotton growing.

The yields of cotton fluctuate considerably in Bugerere and are generally on the low side; the total production of the proposed segregated area should, however, be sufficient to plant up the Gombolola of Mutuba VI, Kyagwe, in the following season.

### Variety Trials.

The *Main Variety Trial* at Bukalasa consisted as usual of eight varieties, laid out as a Latin Square.

The varieties under trial were as follows:—

B.P.52 (Selected at Bukalasa from Nyasaland Upland).

B.P.79 (Selection from Local—B.37—B.P.50).

B.P.89 (Progeny of B.P.52).

B.P.104 (Progeny of S.G.23/8).

S.P.87 (Selection from U.4/4/2).

X.36 (Bulk of B.P.50 progenies from previous season's pedigrees).

X (A mixture of S.G.23/8, B.P.79 and B.P.52).

Local Buganda.

Germination was satisfactory although weather conditions were not too favourable in the early stages. Subsequent growth was very slow indeed and at no time did the plants reach the normal size of development. With regard to habit of growth there was little to choose between the varieties and with such small plants very little lodging occurred.

The only two diseases of importance were Blackarm and Wilt. Records of Blackarm infection showed statistical significance and S.P.87 gave fewer lesions per plant than any variety except Local; Local gave less than the remainder except X and B.P.52; and all varieties were better than B.P.89. The performance of B.P.52 was particularly satisfactory in this respect as also was that of B.P.104 which showed considerably more resistance than the original parent S.G.23/8.

The following Table gives a summary of the Blackarm observations:—

| Variety.                        | Mean Lesions<br>per plant. | Percentage<br>plants with no<br>lesions. | Mean Lesions<br>per infected<br>plant. |
|---------------------------------|----------------------------|------------------------------------------|----------------------------------------|
| S.P.87 .. .. .                  | 0.61                       | 68                                       | 1.89                                   |
| Local .. .. .                   | 1.04                       | 61                                       | 2.64                                   |
| B.P.52 .. .. .                  | 1.26                       | 63                                       | 3.32                                   |
| X .. .. .                       | 1.28                       | 56                                       | 2.84                                   |
| B.P.79 .. .. .                  | 1.71                       | 39                                       | 2.76                                   |
| B.P.104 .. .. .                 | 1.74                       | 38                                       | 2.76                                   |
| X.36 .. .. .                    | 2.53                       | 30                                       | 3.62                                   |
| B.P.89 .. .. .                  | 3.83                       | 19                                       | 4.70                                   |
| Least Significant Difference .. | 0.66                       | ..                                       | ..                                     |

It is obvious that both X.36 and B.P.89 are very susceptible to Blackarm as they had a high infection despite the fact that the season was very dry and not favourable to spread of Blackarm. With B.P.52 there is evidence that splitting for Blackarm resistance is occurring and efforts are being made to isolate the resistant portion.

Wilt occurred in definite patches only and it was noticeable that these were in similar situations to those where Wilt had occurred in the 1934/35 season. It appeared that B.P.79, X.36 and S.P.87 were the most susceptible varieties but statistical evidence of this was not forthcoming.

In the absence of any trained Entomological staff no statistical estimation of insect attack was possible but at the same time ordinary observations were carried on. *Lygus* was present in normal quantities but no varietal reaction to attack was observed.

Picking commenced early in December and was completed before the end of February, the earliest end of season ever recorded at Bukalasa.

Considering the stunted condition of the plants the yields obtained were remarkably good and the percentage of fift was low. The yields, etc., are given below:—

| Variety.                           | Yield<br>seed-cotton<br>per acre. | Yield<br>Lint<br>per acre. | Percentage<br>"Fift". | Ginning<br>Outturn. | Lint<br>Length. | Yield of<br>1st quality<br>Lint per<br>acre.<br>lbs. |
|------------------------------------|-----------------------------------|----------------------------|-----------------------|---------------------|-----------------|------------------------------------------------------|
|                                    | lbs.                              | lbs.                       |                       | %                   | mm.             |                                                      |
| Local .. .. .                      | 1,371                             | 416                        | 4.5                   | 30.4                | 26.8            | 397                                                  |
| B.P.104 .. .. .                    | 1,327                             | 408                        | 3.9                   | 30.8                | 29.9            | 393                                                  |
| B.P.52 .. .. .                     | 1,268                             | 401                        | 3.5                   | 31.6                | 30.2            | 387                                                  |
| B.P.89 .. .. .                     | 1,186                             | 386                        | 3.7                   | 32.5                | 29.7            | 372                                                  |
| X .. .. .                          | 1,152                             | 371                        | 5.1                   | 32.2                | 29.8            | 355                                                  |
| X.36 .. .. .                       | 1,126                             | 355                        | 4.7                   | 31.6                | 30.4            | 339                                                  |
| B.P.79 .. .. .                     | 1,031                             | 305                        | 5.2                   | 31.4                | 30.3            | 307                                                  |
| S.P.87 .. .. .                     | 980                               | 370                        | 7.7                   | 37.7                | 28.7            | 341                                                  |
| Least Significant<br>Difference .. | 169                               | 46                         | 1.7                   | ..                  | 1.1             | ..                                                   |

With seed-cotton, Local gave a significantly greater yield than all except B.P.104 and B.P.52; B.P.104 greater than all except B.P.89 and B.P.52, and B.P.52 greater than B.P.79 and S.P.87. The interesting point arising out of these yields is that on comparing them with the previous season's yields,

B.P.52 has dropped 160 lbs. per acre while Local has gained over 500 lbs. per acre. This is entirely a seasonal effect as in the present season late maturing cottons produced top yields whereas in the previous season they did not. The reason for this is rather obscure as in such a short season it would be expected that late maturing varieties would suffer. Actually the answer is that in a late or long season the early maturing varieties produce a second crop which the late maturing ones do not. With lint the only radical change from the seed cotton position is S.P.87 which by virtue of its very high ginning outturn is only surpassed by Local. This variety, however, gave a high percentage of stained and low grade cotton and was in fact worse than all other varieties in this respect.

Considerable variation in earliness, which is an important factor in a Pink Boll-worm area, was observed and B.P.52 again matured earlier than any other variety while Local and B.P.104 were comparatively late maturing. B.P.52 produced 45% of its total crop by the end of January as compared to Local 32% and B.P.104 25%.

Samples of seed cotton were combed from each plot and an analysis of variance was worked out, the results of which are included in the table above. The short staple of Local is noteworthy, it is significantly shorter than any other variety; while S.P.87 is shorter than all except Local.

Some indication of soil effect on length was shown as the bottom row of plots gave the shortest staple in nearly every variety.

Examination of lint samples by Local Lint Buyers has shown the superiority of B.P.52 over all others. Its lint is long, it is stronger and more uniform and is expected to command a substantial premium over Local.

### District Variety Trials.

These were held at the same centres as the previous season, the four varieties being Local, B.P.52, B.P.79 and X. In no individual case was any significant difference in yield obtained, nor did the combined analysis show differences. The most useful information which came out of the results is that B.P.52 yields at least as well as Local and with its higher ginning outturn and much superior lint will be worth considerably more per acre than Local. The Kalagala Trial figures are remarkable as in October the cotton was defoliated completely by hail which was followed by a serious attack of Blackarm. Despite this set-back B.P.52 yielded over 1,000 lbs. per acre.

The bulk mixture, X, did not show any particular promise and it is doubtful if it is worth proceeding with.

### *Yields. Seed Cotton per Acre.*

| Centre.        | Local. | B.P.52. | B.P.79. | X.    |
|----------------|--------|---------|---------|-------|
| Bukalasa ..    | 1,384  | 1,236   | 1,007   | 1,049 |
| Mukono ..      | 1,152  | 1,322   | 1,182   | 1,178 |
| Kalagala ..    | 725    | 1,025   | 620     | 798   |
| Kitala ..      | 359    | 433     | 290     | 410   |
| Kabasanda ..   | 1,283  | 1,388   | 1,283   | 1,316 |
| Nkozi ..       | 544    | 472     | 392     | 600   |
| Kalungu ..     | 690    | 920     | 1,020   | 1,020 |
| Kyanamukaka .. | 1,068  | 1,032   | 1,032   | 1,000 |
| MEAN ..        | 900.5  | 978.5   | 853.3   | 921.4 |



The low yields at Kitala and Nkozi were due to bad soil and are obviously not typical of the areas which they represent. Kitala has been abandoned as a centre and the Nkozi plot is being changed for a more typical one.

### Spacing and Variety Trial.

The varieties B.P.52 and Local were planted at two spacings  $4' \times 1\frac{1}{2}'$  (control) and  $3' \times 1'$ .

This season the cotton was planted early so as to obtain some information as to the effect of closer spacing on early sown cotton. No varietal differences were obtained and no interaction between variety and spacing. The closer spacing gave significant increases in yield for both varieties.

*Yields in Lbs. Seed-Cotton per Acre.*

| Variety.     | Spacing.                  |                | Mean  | Least Significant Difference. |
|--------------|---------------------------|----------------|-------|-------------------------------|
|              | $4' \times 1\frac{1}{2}'$ | $3' \times 1'$ |       |                               |
| Local .. ..  | 1,064                     | 1,259          | 1,162 | 124                           |
| B.P.52 .. .. | 1,042                     | 1,217          | 1,129 |                               |
| MEAN .. ..   | 1,053                     | 1,238          | 1,146 |                               |

This experiment will be repeated next season on a more extensive scale as information is required as to the effect of two plants per hole with a  $3' \times 1'$  spacing while the effect of interplanting on close spaced cotton also needs investigating.

### Brokers' and Spinners' Reports.

#### (1) BROKERS' REPORTS.

These reports were made as usual by the Grader attached to the Indian Technological Laboratory and by Messrs. Wolstenholme and Holland of Liverpool. Samples were also examined locally by members of the Liverpool Uganda Company.

The varieties tested at Bombay were B.P.52 and Local from Nkozi and Kabasanda Variety Trials. In both cases B.P.52 was classed as  $\frac{1}{8}$ th inch longer than Local, the values assigned to these cottons being as follows:—

| Centre.      | Local.       | B.P.52.      |
|--------------|--------------|--------------|
| Nkozi .. ..  | Rs. 150/- on | Rs. 160/- on |
| Kabasanda .. | Rs. 150/- on | Rs. 155/- on |

Basis Rs. 219/-.

Of the samples examined in Liverpool B.P.52 was outstandingly the best in every case and was again classed as  $\frac{1}{8}$ th longer than Local.

The following summarises the results:—

| Variety.            | Strength.           | Length.                     | Value.<br>pence<br>Per lb. | Points<br>on or off<br>Futures. |
|---------------------|---------------------|-----------------------------|----------------------------|---------------------------------|
| <b>Bukalasa.</b>    |                     |                             |                            |                                 |
| Local ..            | Medium ..           | 1 1/16-1 1/8                | 7.64                       | 90 on                           |
| B.P.52 ..           | Strong ..           | 1 3/16"                     | 8.24                       | 150 on                          |
| B.P.104 ..          | Very Strong         | Good 1 1/8                  | 7.84                       | 110 on                          |
| X (mixture) ..      | Strong ..           | Full 1 1/8                  | 7.84                       | 110 on                          |
| <b>Mukono.</b>      |                     |                             |                            |                                 |
| Local ..            | Strong ..           | Good 1 1/8                  | 7.84                       | 110 on                          |
| B.P.52 ..           | Strong ..           | 1.3/16                      | 8.24                       | 150 on                          |
| <b>Kyanamukaka.</b> |                     |                             |                            |                                 |
| Local ..            | Medium to<br>Strong | Good 1 1/8 to<br>full 1 1/8 | 7.94                       | 120 on                          |
| B.P.52 ..           | Strong              | Full 1 1/8 to<br>1.3/16     | 8.14                       | 140 on                          |

Basis: American 6.84d.

## (2) SPINNING TESTS.

These were carried out by the Shirley Institute and the Technological Laboratory of the Indian Central Cotton Committee.

Both series of tests showed the superiority of B.P.52 and it was of particular interest to see that B.P.52 was considered superior to S.G.23/8, the first time a variety has surpassed S.G.23/8.

### *Shirley Results.*

| Variety.            | Count Strength Product. |       |       |       | Highest<br>Standard<br>Count. |
|---------------------|-------------------------|-------|-------|-------|-------------------------------|
|                     | 40's                    | 50's  | 64's  | 80's  |                               |
| <b>Bukalasa.</b>    |                         |       |       |       |                               |
| Local ..            | 2,063                   | 1,911 | ..    | ..    | 43-45                         |
| B.P.52 ..           | ..                      | 2,367 | 2,096 | ..    | 68-70                         |
| B.P.104 ..          | ..                      | 2,130 | 1,936 | ..    | 59-61                         |
| S.G.23/8 ..         | ..                      | 2,179 | 1,996 | 1,755 | 62-64                         |
| <b>Mukono.</b>      |                         |       |       |       |                               |
| Local ..            | 2,160                   | 1,995 | 1,863 | ..    | 49-51                         |
| B.P.52 ..           | ..                      | 2,310 | 2,015 | 1,914 | 69-71                         |
| <b>Kyanamukaka.</b> |                         |       |       |       |                               |
| Local ..            | 2,254                   | 2,091 | ..    | ..    | 54-56                         |
| B.P.52 ..           | ..                      | 2,222 | 2,067 | ..    | 68-70                         |

The reports on these cottons were as follows:—

"The three samples of B.P.52 gave the strongest yarns. The best sample is B.P.52 (Bukalasa) being one of the three strongest and also one of the best in yarn appearance. B.P.104 and S.G.23/8 are very similar to each other in spinning quality. B.P.52 is superior to Local in all three localities being considerably stronger and similar in yarn appearance. In contrast to the results of previous years' tests, S.G.23/8 has not this time shown the marked superiority in spinning usually exhibited by this variety, the results being more in accordance with the hair character tests".

*Hair Characters.*

| Variety.    | Mean<br>length.<br>mm. | Effective<br>length.<br>(32 inch). | %<br>Normal<br>hairs. | Hair wt.<br>per cm.<br>10·5 mgrm. |
|-------------|------------------------|------------------------------------|-----------------------|-----------------------------------|
| Local ..    | 23·0                   | 39                                 | 52                    | 170                               |
| B.P.52 ..   | 23·8                   | 42                                 | 42                    | 127                               |
| B.P.104 ..  | 23·0                   | 40                                 | 51                    | 149                               |
| S.G.23/8 .. | 22·2                   | 40                                 | 54                    | 150                               |

*Indian Central Cotton Committee.*

| Variety.          | Count Strength Product. |       |       | Highest<br>standard<br>warp counts |
|-------------------|-------------------------|-------|-------|------------------------------------|
|                   | 30's                    | 40's  | 50's  |                                    |
| <b>Nkozi.</b>     |                         |       |       |                                    |
| Local ..          | 1,975                   | 1,744 | 1,575 | 45                                 |
| B.P.52 ..         | 2,096                   | 2,018 | 1,916 | 50                                 |
| <b>Kabasanda.</b> |                         |       |       |                                    |
| Local ..          | 1,854                   | 1,663 | 1,519 | 44                                 |
| B.P.52 ..         | 2,156                   | 1,861 | 1,681 | 50                                 |

The report states, *inter alia*: "Both in Nkozi and Kabasanda, the improved variety B.P.52 gave a much better performance than the Local cotton although its yarns are somewhat more neppy than those of the latter cotton."

*Fibre Particulars.*

| Variety.          | Fibre length (inch). |                  | Fibre weight<br>per inch<br>(Millionth of<br>an ounce). |
|-------------------|----------------------|------------------|---------------------------------------------------------|
|                   | Balls<br>sorter.     | Balls<br>sorter. |                                                         |
| <b>Nkozi.</b>     |                      |                  |                                                         |
| Local ..          | 1·06                 | 1·06             | 0·137                                                   |
| B.P.52 ..         | 1·15                 | 1·16             | 0·122                                                   |
| <b>Kabasanda.</b> |                      |                  |                                                         |
| Local ..          | 1·02                 | 1·06             | 0·144                                                   |
| B.P.52 ..         | 1·13                 | 1·12             | 0·155                                                   |

It is unexpected to find that at Kabasanda B.P.52 is actually coarser than Local.

**(3) ACKNOWLEDGMENTS.**

Thanks are due to the Empire Cotton Growing Corporation, the Indian Central Cotton Committee, the Shirley Institute and Messrs. Wolstenholme and Holland for so kindly arranging and carrying out the tests on Uganda cottons. Thanks are also due to the Liverpool Uganda Company for valuable assistance in grading samples and obtaining spinning reports on new varieties, and to Messrs. Narandhas Rajaram and Co., for ginning many small samples for the above tests.



## Diseases.

## WILT.

The search for Wilt resistant varieties continued and the position is now further complicated by the fact that a *Verticillium* wilt is present also, which attacks cotton with a devastating effect similar to *Fusarium* wilt. In general considerably less Wilt was observed this season than for the past three years; this was undoubtedly due to dry conditions checking the spread of the disease. In many cases soil temperatures were probably higher than the maximum that Wilt can stand and this has some bearing on the comparatively slow rate of spread of the disease throughout the country. Even at Bukalasa Wilt was rare this season except on certain plots. The most interesting plot was that portion of the breeding plot which was the first to show Wilt at Bukalasa, in 1930. In that year less than a dozen plants died from Wilt and these were confined to two strains—B.37 and B.39. The land was rested until 1933 when it was opened up for cotton again. That year about 10% of the total plants were attacked by Wilt, and the plot was put down to elephant grass for a further two years fallow, to be opened up again in 1936. In 1936 this particular portion was planted with New Selections, half of which had been selected in the previous season by the Plant Pathologist for freedom from Wilt. By the middle of November no less than 80% of the plants in this plot were infected with Wilt, most of which infection must have come from the soil. As has been mentioned in the Breeding Plot section, at least two strains showed remarkable recovery from the disease and at the end of the season they showed no external symptoms of the disease while good yields were obtained from individual plants.

*Wilt Free Varieties.*

Six American varieties, resistant to *Fusarium* Wilt in America, were imported and grown during the year in soil known to be infected with Wilt. Three out of the six varieties were completely free of Wilt while the other three had 4, 1 and 1 plants infected respectively. The lint characters of these varieties are far below Uganda requirements and in addition it is likely that most of them will be susceptible to Jassid owing either to complete absence of, or very sparse distribution of, hairs on the leaves. If Wilt resistance continues in the three varieties crosses will be made with local varieties.

*Other Varieties.*

The Plant Pathologist grew a number of seedlings of B.P.50, B.P.52 and S.G.23/8 in pots with heavily infected soil. Any plants becoming infected were destroyed and the remainder were planted out at Bukalasa in a plot, the soil of which was known to be infected with Wilt. The majority of the plants "took" but they remained very stunted and yielded very badly. Only three or four plants, however, succumbed to Wilt and the seed from the remainder is being bulked for a more extensive trial next season.

*Wilt Bulk Plot.*

The Wilt Mass Bulk was sown again and about 10% of the plants were discarded on account of the disease. Some of the plants, badly damaged by Blackarm, were removed as being of little value. Some of B.P.50, selected for apparent resistance to Wilt, was grown in this heavily infected plot and only 2—3% of the plants became diseased.

### *Varieties.*

It is too early for any statement with regard to resistance of new varieties but as far as can be ascertained at present B.P.50 and its derivatives are definitely susceptible, U.4 derivatives appear to be fairly susceptible, S.G.23/8 and its derivatives appear to have some resistance, while B.P.52 does not seem to be particularly susceptible. There are indications that B.181 is resistant.

### **BLACKARM.**

The dry conditions prevented any serious outbreak of Blackarm and selection for resistance was not easy. Any varieties showing large numbers of lesions were discarded as likely to suffer severely under normal, and wet conditions. B.P.89, a selection from B.P.52, is definitely susceptible and has been discarded. B.P.50 and its derivatives are more susceptible than Local which is on the whole comparatively resistant—this resistance possibly accounts for the fact that Blackarm has never been serious in Buganda. No doubt natural selection has played its part here and very susceptible types have died out.

### **Insect Pests.**

Pests were not serious except for Pink Boll-worm which reached a high prevalence in the Mass Selection Plot. *Lygus* did a normal amount of damage while *Helopeltis* was absent except on early sown plots. Despite the dry conditions Jassids were never prevalent even on reputed susceptible varieties such as S.G.23/8.

### **Seed Cotton Samples.**

Samples were examined from various parts of Buganda. The lint length was short, particularly so in Masaka District where the predominating cotton is N.17. The length of lint in Buganda appears to be stabilised round about 27 mm., 3 mm. shorter than what is taken to be our standard of 30 mm. Ginning outturns were round about 30%, very seldom higher. Strength on the whole was weak and very variable.

### **Cassava.**

The collection of varieties has been maintained and increased. In addition to local varieties a number of West Coast and West Indian varieties reputed to be Mosaic-resistant were obtained from Amani. Of these, the variety Black-stick has already become more heavily infected with Mosaic than any other variety and the varieties Parasol, Calabar, Mama l'enfant, and Jamaica 2 have become slightly infected.

The varieties are being tested for palatability, storm resistance, disease resistance, longevity, etc.

The question of longevity is of great importance from the famine point of view as what is required for Buganda is a variety which will remain in good condition in the soil for as long a period as possible. There are three distinct groups of Cassavas: (1) Short period Cassavas such as Bintiminsi, Amani, Kakutya, Machunde, Kalete, Red Jacket, Mugowa, Kazinga which are ready after 6-7 months and do not last longer than 18 months. The usual test for maturity in this group is the production of seeds; as soon as this starts the tubers are edible. (2) Cassavas which ripen in 6-9 months but which remain in good condition for 18-24 months or more—of these varieties Karagwe, Nkwewe, Kiwoko, are examples. (3) Cassavas which take more than 18

months to ripen, e.g., Nakasuga (Nodewide), Nachachali, Nakitembe, Isreari (Nakasoga).

The following varieties have been observed to be definitely susceptible to Mosaic: Nakachachali, Mukedi, Nyumbezunga, Nakitembe, Black-stick, Greyhound, Kayinja, Mulanda.

The following have shown no sign of the disease: Mukabulu, Sofe, Kiwoko, Numbu, Isreari, Bobby Hanson, Bafuta, Gampwanyi, Kazinga, Machunde, Kakutya, Makerere, Japani, Mukibi, Londoni, and several numbered varieties from Amani. The fact that these have shown no infection must not be taken to mean that they are immune as some of them have been exposed to infection for less than a year.

The two varieties Bintiminsi and Nakasuga (Nodewide) are both highly resistant and evidence to-date indicates that the disease has no effect whatsoever on them. Bintiminsi belongs to the 1st group referred to above and is therefore of no use as a famine reserve cassava. Nakasuga, on the other hand, belongs to group 3 and is therefore of distinct value for famine. Only a few instances of Mosaic have been found on this variety.

With regard to palatability very few of the varieties at Bukalasa appear definitely to be unpalatable. Bobby Hanson, Smalling, Red Jacket, Bunch of Keys, Nyumbezunga, are the most unsatisfactory in this respect. It is interesting that the variety "Nyumbezunga" was at one time very popular in Buganda as a famine crop but although it is still grown it is classed as a bitter variety, the general consensus of opinion being that it has deteriorated. The name Nyumbezunga has a literal meaning "the house staggers" and it is so called because in times of famine people used to eat a lot of it and it had an effect similar to excess of alcohol.

During the year two diseases new to cassava in this country were recorded at Bukalasa—one was *Verticillium* Wilt which gave typical Wilt symptoms, and the other Angular Leaf Spot and Blackarm. In the case of Wilt only a few branches were affected in any one bush but the disease invariably showed up in the roots. Palatability tests showed no deterioration in quality but there is no doubt that the disease would affect seriously roots of those varieties which remain in the ground for anything up to five years. The varieties suffering from Wilt were Mukabulu, Karagwe, Nkwewe, Sofe, Kiwoko, Bintiminsi, Mulanda, Brown-stick, Smalling, Kayinja, Grey-hound, Nodewide, and Nakachachali. The most susceptible appeared to be Kayinja and Mukabulu. Nearly all the plants suffering from Wilt were confined to one particular area which had not been used for cassava before. It is probable that the soil was infected especially as it is very close to a bad "Wilt" patch in the neighbouring cotton variety trial plot.

Some work on seed production was done, fair germination was obtained. A preliminary trial of crossing failed.

### Sim-Sim.

Work on the isolation of pure lines has continued and at least five types now breed true. It has been the aim to produce pure lines of those varieties having double, or eight, loculi in the capsule; three such varieties have been isolated but unfortunately this particular type appears to be correlated with fasciation which reduces the yield considerably; further work on this malformity is in progress. A count of seeds per capsule showed that the 8-locked capsules gave an average of 101 seeds as compared with 66 in the four-locked.



Dark seeded types have been eliminated and all work is being concentrated on white seeded forms.

Improvement in yield and reduction in the maturation period are the main objects of the selection work. The pure lines are being bulked as rapidly as possible so as to provide material for a yield trial.

### Yams, Tannias, etc.

A collection of these has been started, material having been obtained from all over the country. The main types of yams collected are:—

|                                      |                             |
|--------------------------------------|-----------------------------|
| Nandigoya.                           | Kisebe ( <i>D. Alata</i> ). |
| Balugu                               | Kyetutumula.                |
| Ndagu.                               | Kikongo.                    |
| Kobe ( <i>Dioscorea bulbifera</i> ). |                             |

### Tobacco.

Varieties were maintained and selection for resistance to leaf curl and Mosaic continued. The whole Burley group gave very poor plants and appeared particularly susceptible to leaf curl. The most satisfactory of the air cured varieties was Hickory Pryor which produces large leaves and does not appear to be so susceptible to Mosaic and leaf curl as most other varieties.

G. W. NYE, *Senior Botanist*.

## (iv) BOTANICAL WORK, SERERE.

### Meteorological Conditions, 1936/37.

The weather cycle of the previous season was repeated with the difference that the season began after the abnormally wet "dry season" experienced in January and February, 1936. As in the previous season May and June were good planting months; the ensuing months were too dry for successful planting and the second rains were short and irregular. October and November were again abnormally hot and dry, inducing cotton to mature rapidly. Except for one heavy rain in December conditions for picking were good right on into January, and by the end of January the crop was virtually finished.

The rainfall for the year 1936 was 58.80 inches, 5.23 inches in excess of the mean for fourteen years, and largely due to the abnormal rains at the beginning of the year. Cotton yields were well above average, so once more there is evidence that a crop planted after a wet "dry season" does well. Yields in Teso District as a whole were even higher than in the previous season, but in the immediate vicinity of Serere the 1935-36 yield level was not quite realised, due no doubt to the partial failure of the second rains.

*Serere 1936-37 Weather Conditions.*

| Month.       | Rainfall.                                               | Sunshine.           | Remarks.                                                              |
|--------------|---------------------------------------------------------|---------------------|-----------------------------------------------------------------------|
| <b>1936.</b> |                                                         |                     |                                                                       |
| April ..     | Nearly 3" <i>above</i> average.                         | Below average.      | The end of a long wet period.                                         |
| May ..       | Nearly 2" <i>below</i> average.                         | Above average.      | Several heavy showers: good for cotton planting.                      |
| June ..      | Slightly <i>above</i> average.                          | Below average.      | Ideal for cotton planting.                                            |
| July ..      | 2½" <i>below</i> average.                               | Below average.      | Too dry for cotton planting.                                          |
| August ..    | Rather <i>below</i> average.                            | Above average.      | A few good showers.                                                   |
| September .. | Rather <i>above</i> average.                            | Above average.      | Wet but rather hot.                                                   |
| October ..   | Nearly 3½" <i>below</i> average.                        | Above average.      | Hot and dry.                                                          |
| November ..  | Very dry indeed.                                        | Much above average. | Very hot and dry: cotton matured rapidly.                             |
| December ..  | Nearly 2" <i>above</i> average, due to one heavy storm. | Below average.      | Hot, but overcast. One very heavy rain.                               |
| <b>1937.</b> |                                                         |                     |                                                                       |
| January ..   | Rather <i>above</i> average.                            | Above average.      | Hot and dry. Cotton picking completed under ideal conditions          |
| February ..  | Over 3" <i>above</i> average.                           | Below average.      | Rains broke early and induced a top crop on some of the later cotton. |
| March ..     | Over 1" <i>below</i> average.                           | Above average.      | Hot; rains failed to a large extent.                                  |

**Diseases and Pests.**

Blackarm disease was not much in evidence, the reason again being the hot dry weather in the two critical months of July and November.

Considering the season the proportion of stained cotton was high. The report of the Entomologist, Mr. A. M. Gwynn, is interesting in this respect. Stained and rotted cotton was noticeable in the more Blackarm-susceptible strains. The local crop had a strong tendency to yellow in storage.

For full details of the insect pests reference should be made to Mr. Gwynn's report.

Last season the results of Blackarm research appeared as an Appendix to the Plant Pathologist's Annual Report. This season's work on Blackarm disease is included in the body of this report.

**The Cotton Breeding Plot.**

The cotton breeding plot was planted on July 5th, 1936; the stands obtained were good in the conditions then prevailing.

## (1) PEDIGREE LINES.

*Biological Characters.*

| Strain.        | Origin.                  | Parent. | Blackarm Lesions<br>per Plant. |                       | Jassid<br>Index* |
|----------------|--------------------------|---------|--------------------------------|-----------------------|------------------|
|                |                          |         | Total<br>Lesions.              | Stem Lesions<br>only. |                  |
| S.P.105        | .. U.4/4/2               | S.F.90  | 0.03                           | nil                   | 2.00             |
| S.P.122        | .. "                     | S.P.92  | 0.11                           | nil                   | 1.35             |
| S.P.123        | .. "                     | "       | 0.05                           | "                     | 1.60             |
| S.P.124        | .. "                     | "       | 0.11                           | "                     | 1.05             |
| S.P.126        | .. "                     | "       | 0.11                           | "                     | 1.40             |
| S.P.134        | .. "                     | S.P.99  | 0.15                           | nil                   | 1.55             |
| S.P.135        | .. "                     | "       | 0.11                           | "                     | 2.10             |
| S.P.136        | .. "                     | "       | 0.08                           | "                     | 2.85             |
| S.P.137        | .. S.G.29 hybrid.        | S.P.102 | 0.04                           | nil                   | 0.90             |
| S.P.138        | .. " "                   | "       | 0.07                           | "                     | 0.80             |
| B.P.50 S1.     | .. Buganda Local         | B.P.50  | 1.64                           | nil                   | 0.90             |
| B.P.50 S2.     | .. " "                   | "       | 0.72                           | "                     | 1.15             |
| B.P.50 S3.     | .. " "                   | "       | 0.48                           | "                     | 1.15             |
| B.P.50 S4.     | .. " "                   | "       | 0.93                           | 0.02                  | 1.00             |
| Control S.G.29 | Nyasaland<br>Upland N.13 | ..      | 1.00                           | 0.04                  | 1.00             |

\* JASSID INDEX.—The mean number of Jassid nymphs per plant (based on 10 leaves per plant) divided by the number of Jassid nymphs on the adjacent control rows of S.G.29. The index is a mean of two counts made on November 16th and December 10th, 1936, and gives a more accurate comparison between the new strains and S.G.29 than the absolute nymph figures, since there is a pronounced "place effect" in the plot.

*Biological Characters.*

| Strain            | Habit.                                   |
|-------------------|------------------------------------------|
| S.P.105 .. ..     | Good, Upright. Early.                    |
| S.P.122 .. ..     | Tall and rather woody. Late.             |
| S.P.123 .. ..     | Fairly tall and rather woody. Late.      |
| S.P.124 .. ..     | Rather tall. Fairly early.               |
| S.P.126 .. ..     | Good, Small plants. Late.                |
| S.P.134 .. ..     | Tall and woody. Late.                    |
| S.P.135 .. ..     | Large and woody. Early.                  |
| S.P.136 .. ..     | Irregular habit. Late.                   |
| S.P.137 .. ..     | Good but small. Very late.               |
| S.P.138 .. ..     | Good but fairly small. Late.             |
| B.P.50. S 1 ..    | Irregular, some good. Late.              |
| B.P.50. S 2 ..    | Luxuriant and woody. Late.               |
| B.P.50. S 3 ..    | Irregular; some good. Late.              |
| B.P.50. S 4 ..    | Woody, some good. Late.                  |
| Control S.G.29 .. | Poor, woody and tall; easily laid. Late. |



*Boll Characters.*

| Strain.        | Effective<br>flowers per<br>Plant. | Seed Cotton<br>per Plant.<br>gms. | Seed Cotton<br>per flower.<br>gms. | Ginning*<br>Percentage. | Lint<br>Length*<br>mm. |
|----------------|------------------------------------|-----------------------------------|------------------------------------|-------------------------|------------------------|
| S.P.105 .. ..  | 42.3                               | 58.3                              | 1.38                               | 34.4                    | 31.1                   |
| S.P.122 .. ..  | 29.5                               | 48.8                              | 1.65                               | 38.0                    | 31.3                   |
| S.P.123 .. ..  | 32.7                               | 51.9                              | 1.59                               | 37.5                    | 31.1                   |
| S.P.124 .. ..  | 25.2                               | 35.1                              | 1.39                               | 36.7                    | 32.2                   |
| S.P.126 .. ..  | 18.3                               | 31.7                              | 1.73                               | 37.0                    | 31.5                   |
| S.P.134 .. ..  | 21.9                               | 26.0                              | 1.19                               | 35.9                    | 31.8                   |
| S.P.135 .. ..  | 22.9                               | 24.8                              | 1.08                               | 37.5                    | 32.2                   |
| S.P.136 .. ..  | 29.5†                              | 43.2†                             | 1.46†                              | 35.7                    | 31.4                   |
| S.P.137 .. ..  | 18.4                               | 26.0                              | 1.41                               | 31.3                    | 32.1                   |
| S.P.138 .. ..  | 21.7                               | 31.4                              | 1.45                               | 31.6                    | 31.2                   |
| B.P.50. S 1 .. | 24.7                               | 33.1                              | 1.34                               | 30.8                    | 33.2                   |
| B.P.50. S 2 .. | 28.7                               | 46.7                              | 1.63                               | 31.0                    | 33.7                   |
| B.P.50. S 3 .. | 22.9                               | 42.7                              | 1.86                               | 30.2                    | 33.9                   |
| B.P.50. S 4 .. | 28.3                               | 52.6                              | 1.86                               | 31.1                    | 32.7                   |

\* The yield of seed cotton in the above table is the average of all plants in the line. The ginning percentages and lint lengths are averages of all plants yielding 40 gms. of seed cotton or more; time precluding the examination of cotton from any but the best plants.

† Very poor stand making these figures too high since with good stand the plants would be smaller.

The figure "seed cotton per flower" is a new characteristic to be determined. In previous seasons it has been possible to calculate the percentage of bolls shed. From now on this will not be possible as the number of bolls picked per plant is not registered.

"Seed cotton per flower", however, is the resultant of the following factors: number of bolls shed, size of boll and number of diseased bolls and loculi. It is therefore a very valuable measurable character when considered in conjunction with yield per plant.

S.P.105 appears to be an improvement on its high yielding parent S.P.90 as far as ginning percentage and lint length are concerned, but like its parent it is still "susceptible" to Jassid attack. It is probable that it is not such a high yielder as its parent.

S.P.122, S.P.123, S.P.124 and S.P.126 derived from S.P.92 appear to be a big advance over the latter strain, particularly in respect to ginning percentage. S.P.124 has long lint and good resistance to Jassid, but lower ginning percentage than its brothers. S.P.123 is the most susceptible to Jassid of the four, but appears to be the highest yielder.

S.P.135 and S.P.136 are very susceptible to Jassid. Their lint length has improved at the expense of yield.

The strain S.P.102 derived from a possible hybrid between S.G.29 and some other cotton unknown, gave very good lint and a significantly higher yield than S.G.29. Its ginning percentage was, however, low. The two strains S.P.137 and S.P.138 derived from S.P.102 are markedly resistant to Jassid and show great improvement in lint length and ginning percentage over S.P.102, but it is probable that yield has deteriorated slightly. S.P.138 has high yield and good ginning percentage, but is nearly 1 mm. shorter than S.P.137.

The four selections made at Serere from B.P.50 have given interesting results. All four show very good resistance to Jassid. S.2 and S.4 have improved ginning percentages with increased resistance to Blackarm. Their yields are distinctly better than their parents', and at the same time lint length has not deteriorated. Further selection is aimed at raising their ginning percentages. The results of one season's rigid selection for Blackarm resistance is quite remarkable, particularly B.P.50. S 3. This strain, however, still gives a very poor ginning out-turn.

## (2) SERERE HYBRIDS.

The programme included an F<sub>2</sub> generation and a series of back-crosses both derived from last year's F<sub>1</sub> generation, and a few new crosses.

The tabulation of all the results from this interesting series of hybrids would consume too much space. Therefore only salient results are recorded, particularly those adding to or reversing the conclusions drawn last year.

### *Serere F<sub>2</sub> Generation 1936-37.*

| Number. | Grandparents.<br>♂ × ♀ |                   | Blackarm Lesions per Plant. |                    | Percentage Plants free from Blackarm. |
|---------|------------------------|-------------------|-----------------------------|--------------------|---------------------------------------|
|         |                        |                   | Total Lesions.              | Stem Lesions only. |                                       |
| AC.     | ..                     | S.P.13 × N.17     | 0.44                        | Nil                | 69                                    |
| CA.     | ..                     | N.17 × S.P.13     | 2.43                        | Nil                | 29                                    |
| AD.     | ..                     | S.P.13 × S.G.29   | 1.40                        | 0.13               | 40                                    |
| DA.     | ..                     | S.G.29 × S.P.13   | 2.06                        | Nil                | 31                                    |
| AE.     | ..                     | S.P.13 × S.G.23/8 | 0.76                        | Nil                | 52                                    |
| EA.     | ..                     | S.G.23/8 × S.P.13 | 2.47                        | Nil                | 13                                    |
| BC.     | ..                     | S.P.80 × N.17     | 3.11                        | Nil                | 5                                     |
| CB.     | ..                     | N.17 × S.P.80     | 2.65                        | Nil                | 5                                     |
| BD.     | ..                     | S.P.80 × S.G.29   | 0.61                        | Nil                | 56                                    |
| DB.     | ..                     | S.G.29 × S.P.80   | 1.00                        | Nil                | 33                                    |
| EB.     | ..                     | S.G.23/8 × S.P.80 | 2.42                        | Nil                | 17                                    |
| CE.     | ..                     | N.17 × S.G.23/8   | 3.07                        | Nil                | 13                                    |
| EC.     | ..                     | S.G.23/8 × N.17   | 2.94                        | Nil                | Nil                                   |
| DE.     | ..                     | S.G.29 × S.G.23/8 | 3.86                        | 0.14               | 29                                    |
| ED.     | ..                     | S.G.23/8 × S.G.29 | 4.58                        | 0.05               | 5                                     |
| CD.     | ..                     | N.17 × S.G.29     | 0.77                        | Nil                | 59                                    |
| DC.     | ..                     | S.G.29 × N.17     | 4.50                        | 0.25               | 13                                    |
| AB.     | ..                     | S.P.13 × S.P.80   | 0.91                        | Nil                | 36                                    |

It seems reasonably certain that susceptibility to Blackarm is transmitted by the male parent, though in the records on page 82 of last year's report this effect was masked by the mechanical transmission of the disease from the female parent.

Incidentally this result shows the necessity for making reciprocal crosses of each hybrid and for carrying a definite scheme of hybridization through a number of generations.

*Serere F1 Generation 1936-37.*

| Number. | Parents.<br>♂ × ♀ | Blackarm Lesions per Plant. |                    | Percentage Plants free from Blackarm. |
|---------|-------------------|-----------------------------|--------------------|---------------------------------------|
|         |                   | Total Lesions.              | Stem Lesions only. |                                       |
| BZ. ..  | S.P.80 × B.P.50   | 0.44                        | Nil                | 63                                    |
| ZB. ..  | B.P.50 × S.P.80   | 0.14                        | Nil                | 86                                    |
| B. ..   | S.P.80            | 0.00                        | Nil                | 100                                   |
| Z. ..   | B.P.50            | 0.68                        | 0.09               | 64                                    |

The transmission of susceptibility to Blackarm through the female parent is presumed to be mechanical.

*Serere Back-Crosses 1936-37.*—The records are not quoted in full as in some lines poor stands make the results unreliable. Also mechanical transmission probably masks the true answer.

*Triple-Element Crosses 1936-37.*—A few of these were grown, but they were stunted in habit and rather unsatisfactory. It has been decided to discontinue triple-element crosses and confine the work to simple crosses and back-crosses of the more promising strains.

### (3) NEW SELECTIONS.

Thirty-one U.4.4.2 derivatives and twenty-nine Nyasaland Upland derivatives were planted in the New Selection Series.

Selections for improved lint characters together with high yield, high ginning percentage and high resistance to Blackarm disease were made in the first-named group.

Eight selections made in the districts in the previous season from N.17 gave some interesting results in the second group. The chief difficulty is to increase yield, ginning percentage and Blackarm resistance without losing the good lint characters of the Nyasaland Uplands.

### (4) TRINIDAD HYBRIDS.

Six rows of these were planted. None of these gave good results; no more work will be done on these hybrids, as the crosses made at Serere between acclimatized cottons have proved superior.

### (5) BUSOGA N.17.

A small plot of N.17 (Jinja) was planted and realised approximately 1,000 plants. The seed was divided before planting into four groups; naked, light white fuzzy, heavy white fuzzy, and green fuzzy. At the end of the season a sample row from each group was harvested and the seed type analysed with the following results:—

| Parent Type.                  | Size of Sample (grs.). | No. of seeds of each type. |        |        |        | Weight of 100 seeds (grs.). | Ginning % |
|-------------------------------|------------------------|----------------------------|--------|--------|--------|-----------------------------|-----------|
|                               |                        | Naked.                     | Light. | Heavy. | Green. |                             |           |
| Naked ..                      | 30                     | 162                        | 101    | 19     | 8      | 10.3                        | 30.3      |
| Light ..                      | 30                     | 36                         | 141    | 79     | 33     | 10.4                        | 30.5      |
| Heavy ..                      | 30                     | 0                          | 120    | 144    | 3      | 11.2                        | 30.7      |
| Green ..                      | 30                     | 47                         | 83     | 66     | 98     | 10.2                        | 30.5      |
| Weight of 100 seeds (grs.) .. | ..                     | 10.3                       | 9.9    | 11.3   | 10.5   | ..                          | ..        |



The green fuzzy type appears to split most, and is undesirable in any case as green notes pass through into the lint. The naked type is associated with low ginning out-turn although the above figures do not show this very well.

### Miniature Variety Trial, Serere.

The trial comprised eight varieties replicated five times in blocks. Each plot consisted of three rows of 50 plants each at 3' × 1' spacing.

The chief aim of the trial was to obtain observations on the incidence of diseases and pests. By harvesting only the middle row of each plot it was hoped to obtain a valid measure of yield, but as the trial was sown on an unfavourable date the yields were insignificant.

The results are shown below:—

| Variety.                        | Origin.               | Blackarm<br>Lesion count<br>Infected<br>Members<br>per Plant.<br>30/11/36. | Yield from<br>4 Blocks<br>after<br>eliminating<br>stand.<br>lbs. | Aerial Veg.<br>Matter<br>4 Blocks.<br>lbs. | Seed Cotton<br>per lb. of<br>Veg. Matter.<br>lbs. |
|---------------------------------|-----------------------|----------------------------------------------------------------------------|------------------------------------------------------------------|--------------------------------------------|---------------------------------------------------|
| N.17                            | Nyasaland Upland ..   | 0.75                                                                       | 5.72                                                             | 81                                         | 0.075                                             |
| S.P.93                          | Nariama ex N.17 ..    | 0.22                                                                       | 4.91                                                             | 57                                         | 0.099                                             |
| S.G.29                          | Nyasaland Upland N.13 | 1.30                                                                       | 4.66                                                             | 55                                         | 0.109                                             |
| S.P.102                         | S.G.29 Hybrid ..      | 0.16                                                                       | 5.84                                                             | 46                                         | 0.166                                             |
| B.P.50                          | Buganda Local ..      | 0.30                                                                       | 6.37                                                             | 79                                         | 0.088                                             |
| S.P.90                          | U.4/4/2 via S.P.84 .. | 0.21                                                                       | 5.40                                                             | 54                                         | 0.106                                             |
| S.P.92                          | U.4/4/2 via S.P.87 .. | 0.50                                                                       | 5.41                                                             | 63                                         | 0.097                                             |
| S.P.99                          | do do ..              | 0.59                                                                       | 5.99                                                             | 65                                         | 0.104                                             |
| Least significant difference .. |                       | 0.21                                                                       | ..                                                               | 16                                         | ..                                                |

The outstanding results are:—

- (1) The susceptibility of S.G.29 to Blackarm is considerably more than that of any other variety.
- (2) The vegetative tendency of N.17 and B.P.50; the marked cropping efficiency of S.P.102.

### Combined Variety, Spacing and Sowing Date Trial, Serere.

The experiment was laid out on Block E of the Experiment Farm in precisely the same type of lay-out as in the previous season.

The treatments were:—

|              |       |                                                             |
|--------------|-------|-------------------------------------------------------------|
| Sowing Dates | ..    | May 16th, 1936.<br>June 15th.<br>July 15th.<br>August 15th. |
| Spacing      | .. .. | 3' × ½'.<br>3' × 1'.<br>3' × 1½'.                           |

|                 |                            |
|-----------------|----------------------------|
| Varieties .. .. | S.G.29 (control).          |
|                 | S.P.88 (Nariama).          |
|                 | S.P.89 (ex S.G.29 hybrid). |
|                 | S.P.20 (U.4/4/2).          |
|                 | S.P.84 ( , , ).            |
|                 | S.P.87 ( , , ).            |

## (1) YIELD RESULTS.

The following tables demonstrate the results after converting actual yields to yields per acre.

*Varieties (Irrespective of Spacing or Sowing Date).*

| Varieties.   | Total Cotton<br>Lbs. per Acre. | Least Significant<br>Difference<br>Lbs. per Acre. |
|--------------|--------------------------------|---------------------------------------------------|
| S.G.29 .. .. | 582.5                          | } 36.2                                            |
| S.P.88 .. .. | 710.4                          |                                                   |
| S.P.89 .. .. | 708.0                          |                                                   |
| S.P.20 .. .. | 813.1                          |                                                   |
| S.P.84 .. .. | 747.3                          |                                                   |
| S.P.87 .. .. | 742.2                          |                                                   |

*Sowing Dates (Irrespective of Varieties or Spacings).*

| Sowing Date.     | Total Cotton<br>Lbs. per Acre. | Least Significant<br>Difference<br>Lbs. per Acre. |
|------------------|--------------------------------|---------------------------------------------------|
| Mid May .. ..    | 992.9                          | } 360.6                                           |
| Mid June .. ..   | 941.8                          |                                                   |
| Mid July .. ..   | 615.4                          |                                                   |
| Mid August .. .. | 319.0                          |                                                   |

*Spacings (Irrespective of Varieties or Sowing Dates).*

| Spacings.         | Total Cotton<br>Lbs. per Acre. | Least Significant<br>Difference<br>Lbs. per Acre. |
|-------------------|--------------------------------|---------------------------------------------------|
| 3' x 1/2' .. ..   | 720.5                          | } none.                                           |
| 3' x 1' .. ..     | 723.6                          |                                                   |
| 3' x 1 1/2' .. .. | 707.7                          |                                                   |

*Interaction of Variety x Sowing Date. Yields of Cotton. Lbs./Acre.*

|           | Mid May. | Mid June. | Mid July. | Mid August. | Least Significant<br>Difference<br>Lbs./Acre. |
|-----------|----------|-----------|-----------|-------------|-----------------------------------------------|
| S.G.29 .. | 811.7    | 776.6     | 502.9     | 239.0       | } 102.3 between<br>any entry.                 |
| S.P.88 .. | 997.6    | 931.1     | 581.1     | 331.8       |                                               |
| S.P.89 .. | 951.1    | 919.2     | 638.4     | 323.5       |                                               |
| S.P.20 .. | 1,164.2  | 1,030.1   | 735.4     | 322.9       |                                               |
| S.P.84 .. | 1,034.7  | 1,023.8   | 596.0     | 332.8       |                                               |
| S.P.87 .. | 998.4    | 969.9     | 638.7     | 361.9       |                                               |

The General Mean of the whole trial is 717.3 lbs./acre as compared with 966.5 lbs./acre for a similar trial in the previous season.

*Discussion of Results.*

Varieties (Irrespective of Spacing or Sowing Date):—

- S.P.20 > all other varieties.
- S.P.84 = S.P.87.
- S.P.84 > S.P.88 = S.P.89 > > S.G.29.
- S.P.87 = S.P.88 = S.P.89 > > S.G.29.

Sowing Dates (Irrespective of Variety or Spacing):—

- (a) Mid May =mid June.
- (b) Mid May >mid July>>mid August.
- (c) Mid June =mid July>>mid August.

Spacings (Irrespective of Variety or Sowing Date):—

$$3' \times \frac{1}{2}' = 3' \times 1' = 3' \times 1\frac{1}{2}'.$$

Interaction of Variety  $\times$  Sowing Date.

- (a) First Sowing Date:—  

$$\begin{array}{l} \text{S.P.20} > \text{S.P.84.} \\ \text{S.P.84} = \text{S.P.87} = \text{S.P.88} = \text{S.P.89} \end{array} \left. \vphantom{\begin{array}{l} \text{S.P.20} > \text{S.P.84.} \\ \text{S.P.84} = \text{S.P.87} = \text{S.P.88} = \text{S.P.89} \end{array}} \right\} >> \text{S.G.29.}$$
- (b) Second Sowing Date:—  

$$\begin{array}{l} \text{S.P.20} = \text{S.P.84} > \text{S.P.89} \\ \text{S.P.20} = \text{S.P.84} = \text{S.P.87} = \text{S.P.88} \end{array} \left. \vphantom{\begin{array}{l} \text{S.P.20} = \text{S.P.84} > \text{S.P.89} \\ \text{S.P.20} = \text{S.P.84} = \text{S.P.87} = \text{S.P.88} \end{array}} \right\} >> \text{S.G.29.}$$
- (c) Third Sowing Date:—  

$$\begin{array}{l} \text{S.P.20} = \text{S.P.87} = \text{S.P.89} >> \text{S.G.29.} \\ \text{S.P.20} > \text{S.P.84} = \text{S.P.88} = \text{S.G.29.} \end{array}$$
- (d) Fourth Sowing Date:—  

$$\begin{array}{l} \text{S.P.20} = \text{S.P.84} = \text{S.P.88} = \text{S.P.89} = \text{S.G.29} \\ \text{S.P.87} > \text{S.G.29.} \end{array}$$

Interaction of Variety  $\times$  Spacing.

This interaction just fails to reach significance.

## (2) VEGETATIVE EFFICIENCY.

In the May, 1937, issue of the *East African Agricultural Journal* there appeared a short report on the Vegetative Efficiency of the cotton plant\*. Vegetative Efficiency is an expression obtained by dividing the total yield of seed cotton by the total weight of vegetable matter uprooted at the end of the season, and is therefore the amount of seed cotton produced by one pound of plant material. For the sake of continuity the results of last season's combined variety, sowing date and spacing trial are included together with the results of this season's trial. Some interesting comparisons can be made between the two seasons.

### Varieties (Irrespective of Sowing Date or Spacing).

| 1935/36.                             |                        | 1936/37.                             |                        |
|--------------------------------------|------------------------|--------------------------------------|------------------------|
| Variety.                             | Vegetative Efficiency. | Variety.                             | Vegetative Efficiency. |
| S.G.29 (Control Nyasaland Upland) .. | 0.112                  | S.G.29 (Control Nyasaland Upland) .. | 0.061                  |
| S.P.72 (Nariama from N.17) ..        | 0.125                  | S.P.88 (Nariama from N.17) ..        | 0.062                  |
| —                                    | —                      | S.P.89 (from S.G.29 hybrid) ..       | 0.070                  |
| S.P.20 (from U.4.4.2 via S.P.13) ..  | 0.159                  | S.P.20 (from U.4.4.2 via S.P.13) ..  | 0.080                  |
| S.P.43 do ..                         | 0.156                  | S.P.84 do ..                         | 0.071                  |
| S.P.48 do ..                         | 0.180                  | —                                    | —                      |
| S.P.56 (from U.4.4.2 via S.P.14) ..  | 0.080                  | S.P.87 (from U.4.4.2 via S.P.14) ..  | 0.069                  |
| Least significant difference ..      | 0.011                  | Least significant difference ..      | 0.010                  |

\* "The Vegetative and Nitrogen Efficiency of the Cotton Plant in Uganda" by H. R. Hosking. *East African Agricultural Journal*, Vol. II. May, 1937.

*Conclusions.—*

(i) 1935/36.

S.P.48&gt;S.P.43=S.P.20&gt;S.P.72&gt;S.G.29&gt;S.P.56.

(ii) 1936/37.

(a) S.P.20=S.P.84=S.P.89.

(b) S.P.20&gt;S.P.87=S.P.88=S.G.29.

(iii) Comparing the two seasons.

The 1935/36 season gave much higher yields of seed cotton, and therefore more efficient plants. The most efficient variety in 1936/37 (S.P.20) was only as efficient as the worst variety (S.P.56) in 1935/36. The control variety S.G.29 was 46% less efficient in 1936/37 than in 1935/36 (0.061 efficiency as compared with 0.112). The relative improvement of S.P.87—the U.4.4.2 derivative *via* S.P.14—over its ancestor S.P.56 is of interest.

*Sowing Dates (Irrespective of Varieties or Spacings).*

| 1935/36.                        |    |    |                        | 1936/37.                        |    |    |                        |
|---------------------------------|----|----|------------------------|---------------------------------|----|----|------------------------|
| Sowing Date.                    |    |    | Vegetative Efficiency. | Sowing Date.                    |    |    | Vegetative Efficiency. |
| May 1st .. ..                   | .. | .. | 0.184                  | Mid May .. ..                   | .. | .. | 0.117                  |
| May 31st .. ..                  | .. | .. | 0.135                  | Mid June .. ..                  | .. | .. | 0.138                  |
| July 1st .. ..                  | .. | .. | 0.121                  | Mid July .. ..                  | .. | .. | 0.078                  |
| August 1st .. ..                | .. | .. | 0.094                  | Mid August .. ..                | .. | .. | 0.078                  |
| Least significant difference .. |    |    | 0.050                  | Least significant difference .. |    |    | 0.029                  |

*Conclusions.—*

(i) 1935/36.

(a) May 1st&gt;July 1st =August 1st.

(b) May 1st=May 31st&gt;August 1st.

(c) May 31st=July 1st.

(ii) 1936/37.

Mid May=mid June&gt;mid July=mid August.

(iii) Comparing the two seasons.

The lower efficiency of the 1936/37 season is again evident. The surprising result in the latter season is the low relative efficiency of the earliest planting date.

It will be noted that not only does late planting reduce yield, but it results in lowered efficiency. It follows from this that late planting results in a relatively high drain on the plant nutrients in the soil for a low return in seed cotton, *i.e.*, it is an extravagant practice.

*Spacing (Irrespective of Varieties and Sowing Dates).*

| 1935/36.                        |    |    |                        | 1936/37.                        |    |    |                        |
|---------------------------------|----|----|------------------------|---------------------------------|----|----|------------------------|
| Spacing.                        |    |    | Vegetative Efficiency. | Spacing.                        |    |    | Vegetative Efficiency. |
| 3' × ½' .. ..                   | .. | .. | 0.111                  | 3' × ½' .. ..                   | .. | .. | 0.092                  |
| 3' × 1' .. ..                   | .. | .. | 0.132                  | 3' × 1' .. ..                   | .. | .. | 0.106                  |
| 3' × 1½' .. ..                  | .. | .. | 0.136                  | 3' × 1½' .. ..                  | .. | .. | 0.110                  |
| Least significant difference .. |    |    | 0.012                  | Least significant difference .. |    |    | 0.006                  |



*Conclusions.—*

(i) In both seasons  $3' \times 1\frac{1}{2}' = 3' \times 1' > 3' \times \frac{1}{2}'$ .

(ii) The most efficient spacing in both seasons is the widest, although in both seasons the optimum (not significant) is at  $3' \times 1'$ . Wide spacing increases efficiency but results in lower yield of seed cotton. This is an entirely unexpected result as eye observation had led one to believe that wide spacing resulted in woody plants which gave a low yield in proportion to the size of plant. However, when the very wide spacing of the native cultivator (in Teso about  $3' \times 3\frac{1}{2}'$ ) is being considered it is probably true that not only is yield reduced but absolute efficiency also, since the large areas of soil left unshaded by cotton plants are subjected to unnecessary oxidation and baking by the sun, wind and rain erosion, etc.

## (3) BLACK ARM RESULTS.

Total lesions per plant and Blackarm intensity figures (*vide* Annual Report, Part II, 1935/36 pp. 44–48) were obtained as in the previous season.

Blackarm intensity = No. of lesions per pound of plant material.

This expression gives a better index of intensity, as due allowance is made for size of plant.

*Varieties (Irrespective of Sowing Dates or Spacings).*

| Variety.                     |    |    | Mean<br>Lesions per Plant. | Mean<br>Blackarm Intensity. |
|------------------------------|----|----|----------------------------|-----------------------------|
| S.G.29                       | .. | .. | 1.922                      | 4.88                        |
| S.P.88                       | .. | .. | 0.385                      | 0.80                        |
| S.P.89                       | .. | .. | 0.381                      | 0.87                        |
| S.P.20                       | .. | .. | 0.285                      | 0.69                        |
| S.P.84                       | .. | .. | 0.421                      | 0.89                        |
| S.P.87                       | .. | .. | 0.570                      | 1.30                        |
| Least significant difference |    |    | 0.099                      | 0.32                        |

*Conclusions.—*

(1) Lesions per plant.

(a) S.G.29 >> all others.

(b) S.P.87 > S.P.84 = S.P.88 = S.P.89.

(b) S.P.20 = S.P.89.

(c) S.P.20 < all others except S.P.89.

(2) Intensity.

(a) S.G.29 >> all others.

(b) S.P.87 > S.P.88 = S.P.89 = S.P.20 = S.P.84.

*Sowing Dates (Irrespective of Variety or Spacing).*

| Sowing Date.                 |    |    | Mean<br>Lesions per Plant. | Mean<br>Blackarm Intensity. |
|------------------------------|----|----|----------------------------|-----------------------------|
| Mid May                      | .. | .. | 1.181                      | 2.31                        |
| Mid June                     | .. | .. | 0.374                      | 0.88                        |
| Mid July                     | .. | .. | 0.604                      | 1.19                        |
| Mid August                   | .. | .. | 0.483                      | 1.91                        |
| Least significant difference |    |    | 0.129                      | 0.70                        |

*Conclusions.—*

(1) Lesions per plant.

(a) mid May >> other planting dates.

(b) mid June < mid July.

(c) mid June = mid August.

(d) mid July = mid August.

## (2) Intensity.

(a) mid May &gt;&gt; mid June = mid July.

(b) mid May = mid August.

(c) mid June = mid July &gt; mid August.

The low degree infection for the mid June figures probably explains the superiority of this planting date over mid May in respect to Vegetative Efficiency.

*Sowings (Irrespective of Varieties or Sowing Dates).*

| Spacing.                           | Mean<br>Lesions per Plant. | Mean<br>Blackarm Intensity. |
|------------------------------------|----------------------------|-----------------------------|
| $3' \times \frac{1}{2}'$ .. ..     | 0.789                      | 2.50                        |
| $3' \times 1'$ .. ..               | 0.619                      | 1.27                        |
| $3' \times 1\frac{1}{2}'$ .. ..    | 0.574                      | 0.94                        |
| Least significant<br>difference .. | 0.065                      | 0.22                        |

*Conclusions.—*

## (1) Lesions per plant.

 $3' \times \frac{1}{2}' > 3' \times 1' = 3' \times 1\frac{1}{2}'$ .

## (2) Intensity.

 $3' \times \frac{1}{2}' > 3' \times 1' > 3' \times 1\frac{1}{2}'$ .

The interactions of Sowing Date  $\times$  Spacing, Variety  $\times$  Sowing Date, Variety  $\times$  Spacing and Variety  $\times$  Sowing Date  $\times$  Spacing are all highly significant for Blackarm Intensity. Space does not permit of a full discussion of these results but it is of interest to record that in the first sowing dates S.P.87 is worse than S.P.88, S.P.89, S.P.20 and S.P.84; in the last sowing it is worse than S.P.88 and S.P.20 only, while in the second and third sowing dates there is no difference between the S.P. varieties. Needless to say S.G.29 is consistently worse than the other varieties at all planting dates.

The Intensity interaction of Variety  $\times$  Spacing is significant because S.P.20 shows  $3' \times \frac{1}{2}' = 3' \times 1'$ ,  $3' \times \frac{1}{2}' > 3' \times 1\frac{1}{2}'$  and  $3' \times 1' = 3' \times 1\frac{1}{2}'$ , whereas in all the other varieties  $3' \times \frac{1}{2}' > 3' \times 1' = 3' \times 1\frac{1}{2}'$ .

## (4) LINT YIELDS.

200 gramme samples from each plot at  $3' \times 1'$  spacing were ginned on a 12-inch hand gin. It was not possible to gin samples from the other two spacings— $3' \times \frac{1}{2}'$  and  $3' \times 1\frac{1}{2}'$ . However, it was possible to test the significance of the differences in ginning percentages of the varieties, sowing dates and spacings at the  $3' \times 1'$  spacing.

*Interaction of Variety  $\times$  Sowing Date (Mean Ginning Percentages).*

| $3' \times 1'$ only. | S.G.29 | S.P.88 | S.P.89 | S.P.20 | S.P.84 | S.P.87 | Sowing<br>Date Means. |
|----------------------|--------|--------|--------|--------|--------|--------|-----------------------|
| Mid May ..           | 33.0   | 33.2   | 33.5   | 37.2   | 36.5   | 37.0   | 35.1                  |
| Mid June ..          | 32.5   | 33.2   | 34.0   | 37.6   | 35.8   | 37.2   | 35.0                  |
| Mid July ..          | 33.0   | 32.2   | 33.1   | 36.9   | 35.5   | 36.1   | 34.5                  |
| Mid August ..        | 32.2   | 31.9   | 32.5   | 37.3   | 35.1   | 36.6   | 34.2                  |
| Variety Means ..     | 32.6   | 32.6   | 33.3   | 37.2   | 35.7   | 36.7   | ..                    |

*Conclusions.—*

(1) S.P.20 > S.P.87 > S.P.84 > S.P.89 > S.G.29 = S.P.88. (Least significant difference in ginning percentage between varieties 0.4%).

(2) Interaction of Variety  $\times$  Sowing Date not significant.

(3) Sowing Dates not significant, although the steady decline of ginning percentage with late planting is of great interest. It is possible that if all plots had been sampled this effect would have been demonstrated as significant

### District Variety Trials.

4×4 Latin Squares were laid down at sixteen centres East of the Nile according to the usual plan. For the first time the trials were divided into two series of eight each, using N.17 as control in Busoga and the Northern Province and S.G.29 as control in Teso, Bugwere and Budama.

The sixteen trials averaged 734 pounds of seed cotton per acre. Twelve similar trials averaged 911 pounds per acre in the previous season.

#### Total Yield. Lbs. Seed Cotton per Acre.

| Centre.                             | Nyasaland Upland. |         | U.4/4/2. |         | Least Significant Difference. |
|-------------------------------------|-------------------|---------|----------|---------|-------------------------------|
|                                     | N.17.             | S.P.88. | S.P.20.  | S.P.87. |                               |
| Acholi—Kitgum .. ..                 | 870               | 1,022   | 994      | 869     | ..                            |
| Lango—Ngetta .. ..                  | 348               | 331     | 338      | 332     | ..                            |
| „ —Aduku .. ..                      | 613               | 643     | 561      | 315     | ..                            |
| „ —Kaberamaido .. ..                | 637               | 749     | 874      | 700     | 90                            |
| Busoga—Vukula .. ..                 | 1,448             | 1,196   | 1,076    | 1,200   | ..                            |
| „ —Bugaya .. ..                     | 728               | 921     | 806      | 977     | ..                            |
| „ —Bulopa .. ..                     | 482               | 658     | 680      | 624     | ..                            |
| „ —Iganga .. ..                     | 1,360             | 1,189   | 1,288    | 1,181   | ..                            |
| Means .. ..                         | 811               | 839     | 827      | 800     | ..                            |
| Means as percentage of S.P.20 .. .. | 98                | 101     | 100      | 97      | ..                            |
|                                     | S.G.29.           | S.P.88. | S.P.20.  | S.P.87. |                               |
| Teso—Serere .. ..                   | 609               | 768     | 740      | 702     | 89                            |
| „ —Nyero .. ..                      | 598               | 805     | 770      | 755     | 48                            |
| „ —Katakwe .. ..                    | 493               | 913     | 774      | 944     | 272                           |
| „ —Toroma .. ..                     | 495               | 588     | 698      | 766     | ..                            |
| „ —Kumi .. ..                       | 370               | 460     | 454      | 397     | ..                            |
| Bugwere—Kibale .. ..                | 224               | 304     | 429      | 334     | 86                            |
| „ —Kachumbala .. ..                 | 537               | 666     | 722      | 682     | 96                            |
| Budama—Mulanda .. ..                | 775               | 889     | 1,029    | 1,067   | 189                           |
| Means .. ..                         | 513               | 674     | 702      | 706     | 47                            |
| Means as percentage of S.P.20 .. .. | 73                | 96      | 100      | 101     | ..                            |

There is only one general conclusion to be drawn from the above results, namely that all varieties including N.17 are better than S.G.29. By grouping centres some interesting results are obtained:—

#### Total Yield. Lbs. Seed Cotton per Acre.

| Centres.                                        | Nyasaland Upland. |         | U.4/4/2. |         | Least Significant Difference. |
|-------------------------------------------------|-------------------|---------|----------|---------|-------------------------------|
|                                                 | N.17.             | S.P.88. | S.P.20.  | S.P.87. |                               |
| Iganga and Vukula .. ..                         | 1,404             | 1,193   | 1,182    | 1,190   | 166                           |
| Lango and Acholi .. ..                          | 617               | 686     | 691      | 604     | 63                            |
|                                                 | S.G.29.           | S.P.88. | S.P.20.  | S.P.87. |                               |
| Serere and Nyero .. ..                          | 603               | 786     | 755      | 728     | 45                            |
| Bugwere and Budama .. ..                        | 512               | 620     | 727      | 694     | 68                            |
| All S.G.29 centres (exc. Katakwe, Toroma, Kumi) | 549               | 686     | 738      | 703     | 43                            |
| All S.G.29 centres .. ..                        | 513               | 674     | 702      | 706     | 47                            |

The salient results are:—

- (a) the extraordinary success of N.17 in South-east Busoga.
- (b) the comparative failure of N.17 in Lango and Acholi.
- (c) the failure of S.P.87 in Lango and Acholi.
- (d) the success of S.P.88 at Serere and Nyero and failure in Bugwere and Budama; this failure being largely due to *Helopeltis* attack.
- (e) the failure of S.G.29 in all areas where it is grown as the standard crop.

The following table summarises the results of Blackarm lesion counts made on all the District Variety Trials.

*Mean Blackarm Lesions per Plant.*

| Centre.                 | Nyasaland Upland. |         | U.4.4.2. |         | Least Significant Difference. |
|-------------------------|-------------------|---------|----------|---------|-------------------------------|
|                         | N.17.             | S.P.88. | S.P.20.  | S.P.87. |                               |
| Kitgum .. ..            | 1.705             | 0.710   | 0.445    | 0.760   | 0.365                         |
| Ngetta .. ..            | 0.915             | 0.310   | 0.215    | 0.605   | 0.120                         |
| Aduku .. ..             | 1.625             | 0.335   | 0.265    | 0.645   | 0.305                         |
| Kaheramaido .. ..       | 1.355             | 0.315   | 0.250    | 0.770   | 0.418                         |
| Vukula .. ..            | 0.220             | 0.025   | 0.030    | 0.060   | 0.056                         |
| Bulopa .. ..            | 0.455             | 0.145   | 0.095    | 0.350   | 0.222                         |
| Bugaya .. ..            | 0.285             | 0.020   | 0.050    | 0.100   | 0.107                         |
| Iganga .. ..            | 0.110             | 0.035   | 0.035    | 0.140   | ..                            |
| N.17 Centres .. ..      | 0.834             | 0.243   | 0.173    | 0.429   | 0.072                         |
| Percentage of S.P.20 .. | 482               | 140     | 100      | 248     | 42                            |

  

|                         | S.G.29. | S.P.88. | S.P.20. | S.P.87. |       |
|-------------------------|---------|---------|---------|---------|-------|
| Serere .. ..            | 1.930   | 0.175   | 0.140   | 0.290   | 0.637 |
| Nyero .. ..             | 5.185   | 1.535   | 1.345   | 2.015   | 0.731 |
| Katakwi .. ..           | 2.965   | 0.380   | 0.325   | 0.810   | 0.519 |
| Toroma .. ..            | 3.145   | 0.585   | 0.310   | 1.800   | 0.687 |
| Kumi .. ..              | 2.225   | 0.570   | 0.425   | 0.915   | 0.488 |
| Kachumbala .. ..        | 1.060   | 0.080   | 0.055   | 0.205   | 0.128 |
| Kibale .. ..            | 0.935   | 0.060   | 0.050   | 0.120   | 0.223 |
| Mulanda .. ..           | 0.910   | 0.030   | 0.040   | 0.035   | 0.365 |
| S.G.29 Centres .. ..    | 2.294   | 0.427   | 0.336   | 0.774   | 0.151 |
| Percentage of S.P.20 .. | 683     | 127     | 100     | 230     | 45    |

The chief conclusions to be drawn from the analysis of Blackarm susceptibility figures are:—

1. N.17 is less severely attacked by Blackarm disease than S.G.29 judging by the relative size of the lesion counts on the varieties S.P.88, S.P.20 and S.P.87 in the two groups of trials.

2. S.P.20 and S.P.88 are the most resistant varieties, both being superior to S.P.87.

3. The two control varieties N.17 and S.G.29 are respectively nearly five and seven times as badly attacked as S.P.20.

4. The variety S.P.87, while being inferior to the other two S.P. strains, is still a marked improvement over the controls.

5. In the S.G.29 area the intensity of the Blackarm attack was approximately twice as high as in the N.17 area.



### Quarter Acre Comparisons.

The variety S.P.87 was tested against N.17 in Busoga and Lango and against S.G.29 in Teso, Bugwere and Budama at 41 centres in all. It was found, however, that most of the native instructors had mixed the two varieties at some time during planting or harvesting. The few trustworthy results bear out the conclusions drawn from the District Variety Trials, but as S.P.87 has been found not to be the best of the improved varieties there is no occasion to quote these results in full.

### Cotton Seed Multiplication, Serere.

#### (1) QUARTER ACRE INCREASE STAGE.

S.P.90 yielded at the rate of 1,325 lbs. per acre on a plot that was carrying cotton for the third year in succession—a very remarkable performance. The plots of S.P.92, S.P.93, S.P.99 and S.P.102 were damaged by cattle and the yields are not representative.

#### (2) THREE ACRE INCREASE STAGE.

Block "G" was step terraced and planted with S.P.84, as second string to S.P.87; the latter having reached the 40-acre stage a year before its time. In addition Block "F" was manguum terraced and planted with S.P.84, and the same variety was used for the Soil Erosion Experiment nearby, making a total of about ten acres. The yields were:—

|                                 |                      |
|---------------------------------|----------------------|
| Block "G" .. .. .               | 637 lbs. per acre.   |
| Block "F" .. .. .               | 1,026 lbs. per acre. |
| Soil Erosion Experiment .. .. . | 726 lbs. per acre.   |

In all a total of 7,500 lbs. of seed cotton was obtained. This plan was fortunate as S.P.87 proved unsatisfactory and the S.P.84 yielded just enough seed to supply Mulondo with careful planting.

#### (3) 40-ACRE STAGE.

The 1936 Farm was planted with S.P.87, the sowing dates ranging from May 15th to June 10th. Excellent stands were obtained using the Pilot 2-row planter. The total area planted was only 34.3 acres, as the crop obtained from the 1935 Farm (42.2 acres) was greatly in excess of the requirements for Mulondo. S.P.87 gave a mean yield over the whole area of 656 lbs. per acre. Lygus did a good deal of damage and the crop was mainly set high up on tall spindly plants with no middle or base. The main crop did not ripen until December. A slight top crop ripened in January and by February the crop was virtually finished.

### Cotton Seed Multiplication, Segregated Areas.

#### (1) MULONDO AREA.

This area was supplied with S.P.20 grown on the 1935 Farm at Serere. The planting month by month was as follows:—

|          | May    | June   | July  | August | September | Total. |
|----------|--------|--------|-------|--------|-----------|--------|
| Acres .. | 160 .. | 145 .. | 81 .. | 55 ..  | 27 ..     | 468    |

The acreage in the previous season was 328 acres. It is probable that the increased acreage reflects the popularity of U.4 cotton which started with S.P.1 in the previous season.

#### (2) LABORI-KADUNGURU AREA.

This area was planted with S.G.29 as it was decided not to continue with S.P.1 beyond the Mulondo stage. The plantings per month were as follows:—

|          | May    | June     | July     | August   | September | Total. |
|----------|--------|----------|----------|----------|-----------|--------|
| Acres .. | 616 .. | 1,552 .. | 1,180 .. | 1,297 .. | 230 ..    | 4,875  |

## (3) SERERE-KASILO AREA.

This area was planted with S.G.29. The plantings month by month were as follows:—

|          | May      | June      | July     | August   | September | Total. |
|----------|----------|-----------|----------|----------|-----------|--------|
| Acres .. | 4,995 .. | 12,857 .. | 9,608 .. | 5,332 .. | 101 ..    | 32,893 |

The buying returns and yields per acre were as follows:—

| Area.               | Purchases Lbs. Seed Cotton. |              |              | Percentage of Second and Third Quality. | Yield per Acre (all grades). |
|---------------------|-----------------------------|--------------|--------------|-----------------------------------------|------------------------------|
|                     | 1st Quality.                | 2nd Quality. | 3rd Quality. |                                         |                              |
| Mulondo .. ..       | 197,622                     | 8,226        | 23,825       | 14.0%                                   | 491*                         |
| Labori-Kadunguru .. | 812,283                     | 5,161        | 125,306      | 13.8%                                   | 193                          |
| Serere-Kasilo .. .. | 7,547,292                   | 125,416      | 596,463      | 8.7%                                    | 251                          |
| TOTALS AND MEANS .. | 8,557,197                   | 138,803      | 745,594      | 9.4%                                    | 247                          |

\* The yield of 491 lbs. per acre for all plantings when compared with the yield of the other Segregated Areas is extremely good despite the complete failure of 27 acres planted in September and the near failure of 55 acres planted in August.

In the previous season the yields per acre of all grades for the three areas were:—

|                       |                      |
|-----------------------|----------------------|
| Mulondo .. ..         | 372.2 lbs. per acre. |
| Labori-Kadunguru ..   | 293.8 lbs. per acre. |
| Serere-Kasilo .. ..   | 365.7 lbs. per acre. |
| All three areas .. .. | 356.6 lbs. per acre. |

Comparing the two seasons it will be found that the general level of yield has dropped considerably whereas Mulondo under S.P.20 has increased. The Labori-Kadunguru area has given extremely poor yields for both seasons. It has been said that cotton always goes out of this area to Busoga and Lango, and these yields certainly corroborate this statement.

The climate in Labori-Kadunguru and Mulondo was not favourable for high yields, as the second rains failed almost completely, seriously affecting the late plantings. Furthermore, big rains occurred in November and it has been proved there is a significant negative correlation between yield and the November rainfall.

The weather in the remainder of Serere and Kasilo Sazas was not conducive to high yields, although rather better conditions were experienced as distance from Lake Kioga increased.

### Spinning Tests and Brokers' Reports.

#### (1) EMPIRE COTTON GROWING CORPORATION.

Eleven samples from the 1935-36 crop, mostly from Serere, were sent to the Shirley Institute. As the report contains a mass of detail only the barest summary is quoted here; this, however, is sufficient to bring out one decisive result—the success of S.P.84.

|              | Brokers' Valuation. | Yarn.         | Highest Standard Count. |
|--------------|---------------------|---------------|-------------------------|
| S.P.84 .. .. | 100 on              | Strongest     | 67-69                   |
| S.G.29 .. .. | 120 on              | Good second   | 63-65                   |
| S.P.89 .. .. | 130 on              | Indeterminate | 57-59                   |
| S.P.87 .. .. | 120 on              |               | 51-53                   |
| S.P.20 .. .. | 100 on              |               | 45-47                   |
| Basis .. ..  | 6.94d.              |               |                         |

## Quoting from the Spinning Report:—

“Thus, S.P.84 Serere is one of the best in appearance as well as being the strongest, so that this sample can be considered the best spinning cotton of the Eastern Province group. S.G.29, though very little weaker than S.P.84, is not so good in yarn appearance. (S.P.87 and others) are considerably weaker than either S.P.84 or S.G.29.”

## (2) INDIAN CENTRAL COTTON COMMITTEE.

Four samples from the 1935–36 crop were sent to the Indian Central Cotton Committee. Once again the report contains more detail than would be relevant here. The summary below shows conclusively that this report bears out the evidence of the Shirley Institute report.

|                                          | S.P.84.      | S.G.29.      | S.P.87.      | S.P.20.      |
|------------------------------------------|--------------|--------------|--------------|--------------|
| <b>Grader's Report.</b>                  |              |              |              |              |
| Strength .. ..                           | Good         | Moderate     | Good         | Moderate.    |
| Value above Contract rate ..             | Rs. 150/- on | Rs. 125/- on | Rs. 145/- on | Rs. 125/- on |
| Basis .. ..                              | Rs. 219/-    | Rs. 219/-    | Rs. 219/-    | Rs. 219/-    |
| <b>Fibre Particulars.</b>                |              |              |              |              |
| Balls sorter (ins.) .. ..                | 1.06         | 1.01         | 1.04         | 1.01         |
| Baer sorter (ins.) .. ..                 | 1.09         | 1.04         | 1.01         | 1.02         |
| Weight per inch (millionth of oz.) .. .. | 0.121        | 0.124        | 0.123        | 0.138        |
| <b>Spinning Tests.</b>                   |              |              |              |              |
| Total Loss .. ..                         | 11.4%        | 15.6%        | 12.0%        | 11.5%        |
| Lea Test: Count-Strength (               | 2181 (30.4)  | 2127 (30.3)  | 2010 (30.6)  | 1866 (31.0)  |
| Product (Actual count in                 | 2063 (39.0)  | 1914 (40.2)  | 1743 (40.3)  | 1683 (39.5)  |
| brackets) (                              | 1814 (49.1)  | 1791 (49.6)  | 1547 (50.9)  | 1539 (48.7)  |
| Mean Product .. ..                       | 2019         | 1944         | 1767         | 1696         |
| Highest Standard Count ..                | 52           | 52           | 45           | 44           |

Again S.P.84 and S.G.29 are decisively ahead of S.P.87 and S.P.20. An interesting point is that the Bombay broker puts a high premium on S.P.84 whereas the Liverpool broker does not.

## (3) LIVERPOOL UGANDA CO., LTD.

Reports on three 100 lbs. samples have been received by courtesy of the Liverpool Uganda Co., Ltd., as under:—

|         |    |                  |    |               |
|---------|----|------------------|----|---------------|
| S.P. 1. | .. | Mulondo          | .. | 1935-36 crop. |
| S.P.20  | .. | 40-acres, Serere | .. | 1935-36 crop. |
| S.P.87  | .. | 3-acres, Serere  | .. | 1935-36 crop. |

|                                  | S.P.1. | S.P.20. | S.P.87. |
|----------------------------------|--------|---------|---------|
| Total Loss ..                    | 9.5%   | 12.0%   | 14.0%   |
| Lea Test: Count-Strength Product | 1580   | 1680    | 1620    |
| Count .. ..                      | 39     | 35      | 39.5    |

## (4) BROKERS' REPORTS.

1936-37 lint samples were examined at Serere and the following consensus of opinion given:—

|     |    |         |    |                              |
|-----|----|---------|----|------------------------------|
| 1st | .. | S.P.102 | .. | ex S.G.29 hybrid via S.P.89. |
| 2nd | .. | S.G.29. |    |                              |
| 3rd | .. | S.P.90  | .. | ex S.P.84.                   |

(A proportion of short weak fibre was disregarded in placing this cotton).

|     |    |                       |    |            |
|-----|----|-----------------------|----|------------|
| 4th | .. | { S.P.92<br>S.P.84. } | .. | ex S.P.87. |
| 6th | .. | S.P.87.               |    |            |
| 7th | .. | S.P.20.               |    |            |

Since the above opinion was given evidence has accumulated to show that a proportion of short weak fibre is an inherent character in S.P.90; consequently this variety must cede at least two places.

Once again after a good season we find S.G.29 near the top of the list. The order S.P.84, S.P.87, S.P.20 is maintained in confirmation of all that has been said above.

## (5) GINNING.

The following ginning extraction data have been made available by courtesy of Messrs. East African Gineries, Ltd., and Messrs. Foster Brothers:—

| Sample.    | Origin.    | Ginned<br>at | Seed<br>Cotton. | Lint<br>lbs. | Ginning<br>% | Remarks on Lint.        |
|------------|------------|--------------|-----------------|--------------|--------------|-------------------------|
| (1) S.P.20 | .. Mulondo | Bugondo      | 197,622         | 70,235       | 35.5         | Good, regular, bright.  |
| (2) S.P.20 | .. Serere  | Kyere        | 1,215           | 445          | 36.6         | Much inferior to (1).   |
| (3) S.P.84 | .. "       | "            | 5,551           | 1,936        | 34.9         | Good, regular, full.    |
| (4) S.P.87 | .. "       | "            | 18,236          | 6,583        | 36.1         | Fair, rather wasty.     |
| (5) S.P.90 | .. "       | "            | 1,103           | 365          | 33.1         | Very irregular, bright. |

**Eleusine Coracana.**

*Breeding Plot.*—181 single plant selections were made for 1937 breeding plot.

*Variety Trials.*—

No.1.—A 5×5 Latin Square was laid down as follows:—

|           |    |     |                         |
|-----------|----|-----|-------------------------|
| Plots     | .. | ..  | 12 ft. × 12 ft.         |
| Spacing   | .. | ..  | 6 ins. × 6 ins.         |
| Varieties | .. | (1) | Okiringi.               |
|           |    | (2) | Engenyi.                |
|           |    | (3) | Engomu.                 |
|           |    | (4) | Omududu (beer variety). |
|           |    | (5) | Okwang.                 |

Each plot was sub-divided into two sub-plots to compare synonymous strains from Teso and Lango Districts.

*Yield per Acre. Lbs. Unthreshed.*

|                              |    |    | Teso. | Lango. | Mean. |
|------------------------------|----|----|-------|--------|-------|
| (1) Okiringi                 | .. | .. | 1,676 | 2,081  | 1,879 |
| (2) Engenyi                  | .. | .. | 1,706 | 1,803  | 1,755 |
| (3) Engomu                   | .. | .. | 1,724 | 1,597  | 1,661 |
| (4) Omududu                  | .. | .. | 1,428 | 1,228  | 1,328 |
| (5) Okwang                   | .. | .. | 1,337 | 1,301  | 1,319 |
| Least Significant Difference |    |    | 200   | 200    | 312   |



*Conclusions.*—

- (a) Okwang and Omududu are lower yielders than the other varieties.  
 (b) Lango Okiringi is better than the Teso one.  
 Teso Omududu is better than the Lango one.

No. 2.—A 6×6 Latin Square was laid down with six varieties, plot size and spacing being as in No. 1 trial.

*Yield per Acre. Lbs. Unthreshed.*

| Variety.                     |    |    |    | Origin. | Strain.       | Yield. |
|------------------------------|----|----|----|---------|---------------|--------|
| Engenyi                      | .. | .. | .. | Teso    | mass selected | 1,774  |
| Emoru                        | .. | .. | .. | Lango   | bulk          | 1,704  |
| Okwakoit                     | .. | .. | .. | Teso    | mass selected | 1,462  |
| Local                        | .. | .. | .. | Teso    | control       | 1,386  |
| Emiroit                      | .. | .. | .. | Teso    | mass selected | 1,341  |
| Omududu                      | .. | .. | .. | Teso    | mass selected | 1,215  |
| Mean                         | .. | .. | .. | —       | —             | 1,480  |
| Least Significant Difference |    |    |    | ..      | —             | 146    |

*Conclusions.*—

- (a) Engenyi (Teso) and Emoru (Lango) much better than all others.  
 (b) Okwakoit (Teso) better than Omududu (Teso).

*Increase Plots.*—A large number of strains were increased in small bulk.

**Groundnuts.**

*Breeding Plot.*—67 Bunch type and 40 Spreading type selections were planted in 25 plant rows, and full records taken on disease and yield. Of the Bunch type selections 30 were derived from Philippine Pink. 25 single plant selections were taken from the Bunch type series, and 42 from the Spreading type. In addition 7 Bunch types and 10 Spreading types were carried on to the small increase stage.

*Variety Trial.*—Five Bunch types and five Spreading types were tested in a variety trial but replication was limited by seed supply to such an extent that no useful results were obtained. Yields were quite high, but once more the Spreading types seemed to have the advantage over the Bunch types.

*Rosette.*—The incidence of Rosette disease was low. It appears that the disease is excluded when spacing allows less than 100 sq. ins., per plant, and in the light of this knowledge other attempts at controlling the disease by mulching or restrained weeding become superfluous. In fact, recent agronomical experiments designed to test these latter methods have been planted at close spacings. As the returns from seed rates up to an equivalent of some 50–70 sq. ins., per plant appear to be economic it is possible to select a spacing which satisfies both requirements.

**Sorghum (Mtama).**

(with *Pennisetum typhoideum*).

*Breeding Plot.*—Single plant selection was continued on a collection of varieties from Teso, Lango and Bunyoro Districts and from Kenya and the Sudan. Attention was given to tillering capacity and silage making as well as yield of grain. The results are quite promising. No variety trial was conducted at this stage.

*Increase Plots.*—Small increase plots of all the varieties were sown and also eleven small isolated plots of hard grained varieties from Tanganyika.

*Resistance to Birds.*—Observations have been made both on the Mtama Variety Trial and the collection of mtamas grown for observation purposes. Generally speaking it is found that the *Pennisetums* are badly attacked by birds as are certain of the sweet soft-grained types of Sorghum. Some varieties of the latter groups have proved to be quite unpalatable to birds.

*Storage Properties.*—Thirteen varieties were received from the Tanganyika Territory. These were claimed to be resistant to weevils when stored. This claim appears to be justified but it is too early to make any statements as to the yielding capacity of these strains.

### Tobacco.

A stock of selfed seed was maintained of all varieties, but no curing was undertaken.

### Summary.

High yields of cotton were again obtained at Serere and in most Districts.

No direct comparison between S.G.29 and N.17 was made. N.17 was, however, extraordinarily successful and there can be no question that its performance was better than that of S.G.29, despite another season of low Blackarm infections.

The high yield of S.P.20 was maintained, although, as always in a season of high yields, varietal differences were greatly narrowed down.

S.P.87 failed on the scores of late maturity, relapse from high standard of resistance to Blackarm in U.4, low yield, and unfavourable spinners' and brokers' reports. S.P.84 on the other hand, although not such a high yielder as S.P.20, was better than S.P.87 on all counts, and the consistently favourable reports from spinners and brokers are without parallel in the history of U.4 derivatives at Serere.

The value of early planting was again demonstrated.

H. RIVERS HOSKING, *Botanist.*

J. D. JAMESON, *Agricultural Officer.*

## REPORT ON THE EXPERIMENTAL WORK DONE IN THE NORTHERN PROVINCE 1936/37.

*By THE AGRICULTURAL OFFICER, MASINDI.*

Agricultural development began later in the Northern Province than in other parts of the Protectorate and for this reason it is possible for larger improvements to be effected by propaganda and instruction concerning the more elementary operations than could perhaps be obtained by these means in the other provinces. In view of the fact that the European staff is fully engaged with this work and as there are no experiment stations (except for a small farm, Ngetta, which will be referred to later) experimental work in the Northern Province is not extensive. It is confined largely to simple trials and observations relating to the most important and more immediate problems.

Some detailed experiments are carried out at the Ngetta Farm, funds for which are at present provided by the Lango Native Administration but the amount of experimental work which can be done really thoroughly is limited by the fact that the farm is supervised by an Agricultural Officer who is also in charge of a large and important cotton growing district.

Mention might here be made of developments and changes which have taken place at Ngetta during the year. A farm school has been started for the purpose of training Lango youths to become successful smallholders. There are at present fourteen pupils but it is expected that the average number will eventually be in the region of forty. A European has been appointed to manage the Farm School and as it is considered that his time will be fully taken up with this work it has been decided that he shall not be asked to take any part in the supervision of the Agricultural and Veterinary experimental work. All funds required for the Farm School, including management, are being provided by the Lango Native Administration. Veterinary work which was being carried on at Boroboro has been transferred to Ngetta and will now include the production of good stock for supplying the farm school and those pupils who, having completed the course, are leaving to open up their own small holdings.

### Section I.—Cotton.

#### VARIETY TRIALS AND QUARTER ACRE COMPARISONS.

Variety trials were carried out at three centres in Lango District and at one in Acholi. The varieties were S.P.20, S.P.87, S.P.88 and N.17. Quarter acre comparisons (local and S.P.87) were laid down at nine places in Lango. These are all part of the programme of the Botanist, Serere, and the results are included in his report.

#### SPACING TRIALS.

*Object.*—To compare 3 ft.  $\times$  1 ft. with 4 ft.  $\times$  2 ft. spacing.

*Centres.*—Kibuje and Awelo (Lango).

*Results.*—At both centres there was no significant difference in the yields obtained.

## COTTON AND GROUNDNUT INTERPLANTING TRIAL.

*Object.*—To compare yields of cotton and groundnuts by planting in various ways as follows:—

- |        |                  |                                  |          |
|--------|------------------|----------------------------------|----------|
| (i)    | Cotton alone     | 3 ft. × 1 ft.                    |          |
| (ii)   | Groundnuts alone | 9 × 9 ins.                       |          |
| (iii)  | Cotton           | 3 × 1 ft. with 1 row groundnuts. |          |
| (iv)   | “                | 3 × 1 “ “                        | 2 rows “ |
| (v)    | “                | 4 × 1 “ “                        | 3 “ “    |
| (vi)   | “                | 4 × 1 “ “                        | 4 “ “    |
| (vii)  | “                | 6 × 1 “ “                        | 6 “ “    |
| (viii) | “                | 6 × 1 “ “                        | 7 “ “    |

*Lay out.*—As above. There were six blocks sub-blocked for bunch and spreading groundnuts, each sub-block being divided into eight plots to accommodate the above treatments.

*Centres.*—Ngetta and Kaberamaido.

*Results.*—At both Ngetta and Kaberamaido spreading groundnuts were unsuccessful.

At both centres cotton plus one row of bunch groundnuts did well whilst other treatments were unsuccessful.

## COTTON INTERPLANTING EXPERIMENT.

*Object.*—To test the effect on yield of cotton by interplanting with various crops.

*Lay out.*—Six blocks, sub-blocked for ploughed *versus* unploughed, each block being divided into five for the following treatments:—

1. Cotton only.
2. Cotton and beans.
3. Cotton and cow-peas.
4. Cotton and choroko (*Phaseolus arueus*).
5. Cotton and tepary beans.

*Results.*—Summary and conclusions of statistical analysis.

(a) Ploughed = unploughed except if interplanted with tepary in which case cotton does much better on unploughed than on ploughed land.

(b) Beans do not reduce the cotton yield.

(c) Cow-peas and choroko do reduce the cotton yield.

(d) Tepary does not reduce the cotton yield on unploughed land but on ploughed land it does.

## COTTON WEEDING EXPERIMENT.

*Object.*—To determine the effect on yield of cotton of two methods of weeding.

*Lay out.*—Five blocks sub-blocked for the following two treatments:—

- (1) Normal weeding throughout the growing season.
- (2) Weeded at the following times—
  - One month after sowing.
  - Two months after sowing.
  - Four months after sowing.

*Results.*—No result. Ordinary weeding probably better but experiment insufficiently replicated.



## SOWING DATE OBSERVATION AND DEMONSTRATION PLOTS.

*Lango.*

These were district plots to give a demonstration to natives concerning the value of early planting. The appearance of the strips of various sowing dates clearly indicated this without reference to the figures of yields, which were—

|                                 |               |            |             |             |              |             |              |               |
|---------------------------------|---------------|------------|-------------|-------------|--------------|-------------|--------------|---------------|
| AT OMORO.                       | April<br>22nd | May<br>9th | May<br>23rd | June<br>6th | June<br>25th | July<br>4th | July<br>18th | August<br>1st |
| Yield in lbs. per<br>acre .. .. | 552           | 452        | 692         | 536         | 452          | 216         | 204          | 192           |
| IREDA.                          |               | May        | June        | July        | August       | September   |              |               |
| Lbs. per acre ..                |               | 480        | 510         | 240         | 140          | 80          |              |               |

*West Nile District.*

| Centre.   | Month.       | Yield 1936/37 trials. | 1935/36 yield. |
|-----------|--------------|-----------------------|----------------|
| Aringa .. | June ..      | No rain to plant ..   | 652            |
|           | July ..      | 584 lbs. per acre ..  | 804            |
|           | August ..    | 615 lbs. per acre ..  | 790            |
|           | September .. | 109 lbs. per acre ..  | 640            |
|           | October ..   | No planting ..        | 212            |
| Nebbi ..  |              | 1936/37.              | 1935/36.       |
|           | June ..      | 935                   | 939            |
|           | July ..      | 1,021                 | 709            |
|           | August ..    | 757                   | 574            |
|           | September .. | 285                   | 296            |

These results are consistent with those obtained in former years, *i.e.*, early planting—May, June, and July are the best months for planting in the south of the district (Nebbi Area) whereas rather later planting, July–August, does best in the north. This, however, is not advocated amongst the natives as yet or the result would be that the seed would not be in until September or October.

## Section II.—Tobacco.

## FERTILIZER TRIALS.

*Objects.*—To ascertain the effect of various fertilizers on the yield of tobacco.

*Centre.*—Bulindi, Bunyoro.

- Treatments.*—
1. Sulphate of Ammonia and superphosphate.
  2. Potash and Superphosphate.
  3. Sulphate of Ammonia and Potash.
  4. Sulphate of Ammonia only.
  5. Superphosphate only.
  6. Potash only.
  7. Complete fertilizer.
  8. No fertilizer.

Sulphate of Ammonia  $1\frac{1}{2}$  cwt. per acre.

Superphosphate      2    "    "    "

Sulphate of Potash    2    "    "    "

*Lay out.*—One plot of each was grown every year for the past four years. The plot size was the same each year and the plots were scattered at random over the experimental area on land which had received the same treatment. Blue Pryor (fire-cured) was the variety used.

*Results.*—The yields were:—

| Treatment. | Total Yields (addition of the four years). |
|------------|--------------------------------------------|
| 1 ..       | 552 lbs. per acre saleable tobacco.        |
| 2 ..       | 452 " " " " "                              |
| 3 ..       | 369 " " " " "                              |
| 4 ..       | 372 " " " " "                              |
| 5 ..       | 495 " " " " "                              |
| 6 ..       | 523 " " " " "                              |
| 7 ..       | 527 " " " " "                              |
| 8 ..       | 319 " " " " "                              |

All treatments, except No. 3 (Sulphate of Ammonia and potash) and No. 4 (Sulphate of Ammonia only) give significantly larger yields than No. 8 (no fertilizer). Also Nos. 1, 6 and 7 are all significantly greater than both 3 and 4.

#### DISTRICT TRIALS.

Observation plots of tobacco have been grown in Lango (at Ngetta) and Acholi (Kitgum) every year for the past 3 years, and this will continue for five years so that should consideration be given to the extending of tobacco cultivation to these districts sometime in the future useful information will be available. This year's results were:—

| Variety.        | Ngetta.    |            | Total.<br>(Lbs. per acre). |
|-----------------|------------|------------|----------------------------|
|                 | 1st Grade. | 2nd Grade. |                            |
| White Burley .. | 497        | 110        | 607                        |
| Amorello ..     | 670        | 131        | 801                        |
| Blue Pryor ..   | 580        | 62         | 642                        |

#### *Kitgum (Padibe).*

Trials in Acholi have had to be carried out by a cotton instructor receiving occasional advice and supervision from a European officer. Good crops were obtained the first two years, but last year a European could not make a visit at the time for sowing of beds with the result that this was done too late.

Rains were insufficient when the plants were ready for planting out and the crop failed. These trials have now been moved into the Station itself and this year's progress is promising.

#### SEED PRODUCTION.

At Bulindi (Bunyoro) is a small farm where the chief work is the selection of plants for seed purposes. New varieties are also tried out and staff is trained. Plants for seed are also selected in natives' plots in all parts of Bunyoro and West Nile.

### Section III.—Coffee.

Experimental work with coffee is confined to demonstration observation plots in West Nile and Madi.

In West Nile, at various centres at the higher altitudes are plots of Arabica coffee growing under different kinds of shade trees with a non-shaded plot alongside. It is as yet too early for any definite conclusions to be reached, but the spacing of the shades (*Gliricidia maculata* 6 ft. × 12 ft. and *Laucaena glauca* 6 ft. × 6 ft.) seems to be too close. The coffee is spaced 6 ft. × 6 ft.

Robusta coffee is grown at various centres in West Nile and Madi with the main object of supplying information on the growth of this crop in these areas. This will be of great value if it is decided to encourage natives to take up this

crop. The plots have been mulched with grass from time of planting and are bearing good crops (planted out 1932, 1933 and 1934) but it is by no means certain that they will continue to do this much longer.

#### Section IV.—Pastures.

The main object of work on pasture plants at Ngetta is to evolve a good temporary ley suitable from the point of view of grazing capacity and soil regeneration for the 3-year resting period which occurs in the local rotation. This necessitates investigations on many points and the following work was done during the year.

Observations on small plots of pure stands of local grasses were continued and some imported grasses were added to the collection.

*Seed supply* has been unsatisfactory and difficult so that work to improve this is being done. Information is being attained on the viability of seed of the various pasture plants under local conditions and the best methods of collecting seed. The preliminary results obtained by raising succeeding generations from grasses which grew from seed have been promising.

*Methods of sowing and establishing* have been tried out and the best results have so far been obtained by the following. After the land has been ploughed as early in the year as possible and allowed to weather until May the seed is broadcast on the still rather rough surface. A harrowing with a spike harrow suffices to cover the seed but does not fill up the depressions left after ploughing and these arrest erosion and do much towards ensuring a good stand of plants. It is not considered necessary to attempt to remove the large numbers of weeds which appear during the first two months as the grasses are not long in becoming dominant. Weeding has in fact sometimes been found to be harmful in that numbers of young grass plants are destroyed in the process.

*Sowing Dates* have been varied but May has been found to be the best month under local conditions.

*Mixtures.*—One or two new mixtures were sown and grazing records on mixtures previously established were kept. Figures show that an average of 1.5 oxen per acre can be supported on some of these and during times of good rainfall up to 2.5 oxen per acre were maintained. The time is not yet ripe for details of mixtures sown, results of observations, etc., to be given as no definite conclusions can be arrived at yet and much more work has to be done.

*Time to Commence Grazing.*—Investigations are being made but no definite results have been obtained. It would seem that allowing a fair cover to be maintained is better than close grazing.

*Other work* done during the year included observations on succession after cultivation of various crops, effect of controlled grazing and the laying down of an experiment to compare the residual value of various grasses, when grazed and ungrazed, at the end of a three-year period.

#### Section V.—Other Crops.

**SIM-SIM (Sesame).**

Eight local varieties of sim-sim were grown at Ngetta in observation plots and selections were made for heavy yielding types.

A further four varieties were grown in increase plots and yield trials are being carried out in 1937.

### WIMBI (*Eleusine*).

Large observation plots of five local varieties were grown for selection and increase, and yielded as follows:—

|        |    |    |    |       |                |
|--------|----|----|----|-------|----------------|
| Okuma  | .. | .. | .. | 1,767 | lbs. per acre. |
| Oding  | .. | .. | .. | 1,389 | ,, ,, ,,       |
| Emoit  | .. | .. | .. | 1,071 | ,, ,, ,,       |
| Ayoka  | .. | .. | .. | 1,016 | ,, ,, ,,       |
| Odiero | .. | .. | .. | 659   | ,, ,, ,,       |

An additional eleven varieties were grown in small plots for observation purposes.

### GROUNDNUTS.

#### *Groundnut Mulching and Variety Trial.*

*Object.*—To ascertain the effect on yield of groundnuts (both “Bunch” and “Spreading” varieties) under the following treatments.

The extent to which Rosette disease was present in the various treatments was also investigated.

1. Grass mulch.
2. No weeding in first 3 weeks, clean weeded after.
3. Clean weeding.
4. No weeding at all.

*Lay out.*—Five blocks sub-blocked for “Bunch” and “Spreading” and each sub-block divided into four to accommodate the above treatments.

*Sowing date.*—26th–27th May.

*Results.*—Conclusions from summary of statistical analysis.

1. *Stand of plants.*—There was no difference between varieties and treatments.

2. *Rosette disease.*—

- (a) “Spreading” more Rosette than the “Bunch”.
- (b) Clean weeded=Clean weeding after 1st 3 weeks.  
Grass mulch=No weeding 1st 6 weeks.

Clean weeded and clean weeded after 1st 3 weeks had more Rosette than grass mulch.

3. *Yield of groundnuts.*—

- (a) “Bunch” yielded more than “Spreading”.
- (b) No difference between cultivations and mulch.

### ABROMA AUGUSTA.

This is being grown at Ngetta but has not yet reached maturity.

### RAMIE.

This did well at Bulindi (Bunyoro) but was almost a complete failure at Ngetta (Lango).

### LEMON GRASS.

In the West Nile has yielded as follows (fresh grass):—

|                         |                                      |
|-------------------------|--------------------------------------|
| 1st Cutting (May, 1935) | at the rate of 31,200 lbs. per acre. |
| 2nd „ (December, 1935)  | ,, ,, ,, 28,400 ,, ,, ,,             |
| 3rd „ (November, 1936)  | ,, ,, ,, 25,800 ,, ,, ,,             |



The plot size was too small for these results to be relied upon as being entirely trustworthy but the indication is very promising.

284 pounds of wet grass gave 105 pounds of dry grass which gave 0·77 pounds of lemon grass oil.

### Conclusion.

I would like to record my appreciation of the assistance given by the Botanist, Serere, who has undertaken the statistical analysis of results of experiments.

E. F. MARTIN, *Agricultural Officer.*

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## REPORT ON BUKALASA EXPERIMENT STATION, SEASON 1936-37.

By THE SENIOR AGRICULTURAL OFFICER and THE SENIOR BOTANIST.

### Introduction.

The work of the Botanical and Educational sections carried on at Bukalasa is reported separately. The effect of the three years resting period under elephant grass was clearly shown in the excellent yields obtained from all crops grown on the freshly cleared land. High yields of groundnuts and cotton and the best crop of tobacco yet obtained at Bukalasa showed the value of the resting period. Plenty of trash and decaying root-stocks was present throughout the season with the result that no soil wash whatsoever occurred.

The old blocks were planted with elephant grass and it was found that the most satisfactory method of planting is to use pieces of root at  $2' \times 2'$  spacing. Cuttings grow well if the soil remains moist but they are liable to die out during dry periods with the result that large blank areas may occur which cannot be refilled. Labour conditions were fairly satisfactory and the headmen have shown improvement since last year. There was unfortunately a preponderance of Banyaruanda porters who, though willing, are weak and unable to carry out tasks similar to those done by Acholi porters.

The health of European staff has been good, only three cases of malaria occurring during the year.

### Meteorology.

Full details are given in the Senior Botanist's report on Botanical work. The water supply was more satisfactory than usual although a severe drought in July strained resources to the utmost.

### Cotton.

Cotton yields were good despite the complete absence of any second picking peak. The grade was good and the "fifi" percentage lower than for many years.

### INTERPLANTING EXPERIMENT.

This was a repetition of the one done in previous years. The indications of last season that two rows of the inter-plant crop depress the yield of cotton were confirmed this season, as control (no interplanting) gave a significant increase in yield of cotton over two rows of groundnuts and two rows of beans. Further, beans appear to have a more adverse effect than groundnuts although they are on the land for a much shorter time; on the other hand their yield was more than double that of the groundnuts.

Yields:—

TABLE I.

| Treatment.                      | Yield<br>per acre<br>cotton<br>(lbs.) | Yield<br>per acre<br>groundnuts<br>(lbs.) | Yield<br>per acre<br>beans<br>(lbs.) |
|---------------------------------|---------------------------------------|-------------------------------------------|--------------------------------------|
| Control .. ..                   | 1,292                                 | ..                                        | ..                                   |
| One row Groundnuts .. ..        | 1,247                                 | 126                                       | ..                                   |
| One row Beans .. ..             | 1,159                                 | ..                                        | 332                                  |
| Two rows Groundnuts .. ..       | 1,199                                 | 150                                       | ..                                   |
| Two rows Beans .. ..            | 1,143                                 | ..                                        | 384                                  |
| Least Significant Difference .. | 76.8                                  | ..                                        | ..                                   |

It is interesting to note the very small increase in yield of groundnuts and beans given by the additional row.

#### TWO PLANTS PER HOLE VERSUS ONE.

The results of this experiment were not significant, but highly indicative of an increase due to leaving two plants per hole. Although in few instances has a significant increase been shown, in favour of leaving two plants per hole, yet in every trial conducted at Bukalasa the balance has been in favour of leaving two plants. The yields this season were:—

1 plant per hole 1,138 lbs. seed cotton per acre.

2 plants per hole 1,235 lbs. " " " "

#### GREEN MANURE FOR COTTON.

This experiment was repeated as in previous years—*Crotolaria juncea* being dug in 8, 6, 4 and 2 weeks before the cotton was planted. The results this year were significant and generally favoured green manure despite, or because of, the fact that the experiment was sited on land freshly cleared from a three year fallow under elephant grass. Conditions were not normal in that there was a dry spell immediately after the cotton was planted, with the result that the germination was very poor and refilling could not be done for over a month after the original planting. No differences in the final stands were obtained, this result being due to the long period between digging in the manure and re-planting.

Results:—

| Period between digging in<br>green-manure and planting<br>cotton. |       | Yield Seed<br>Cotton per acre.<br>(lbs.). |
|-------------------------------------------------------------------|-------|-------------------------------------------|
| Control (No green-manure)                                         | ..    | 732                                       |
| 2 weeks                                                           | .. .. | 756                                       |
| 4 weeks                                                           | .. .. | 834                                       |
| 6 weeks                                                           | .. .. | 854                                       |
| 8 weeks                                                           | .. .. | 873                                       |
| Least Significant Difference                                      |       | 80                                        |

Thus 4, 6 and 8 weeks gave better yields than control while 6 and 8 weeks were better than 2 weeks with a strong probability that 4 weeks was better than 2 weeks.

#### TOPPING.

Observation plots to test the effect of topping at various stages of growth, were grown. The results were of little value on account of the dry conditions which occurred throughout the growing season. The topped plants were stunted, and very bushy in the case of those topped early; late topping had no effect. The Control plants were generally better in appearance than the topped ones.

### Rotation Experiments.

#### 1. ECONOMIC MANURIAL EXPERIMENT.

The object of this experiment is to find out if fertility can be maintained by the application of heavy dressings of cotton seed, by green manuring or by a combination of the two. The rotation used is a typical local one:—

|          |    |            |
|----------|----|------------|
| 1st year | .. | Cotton     |
| 2nd year | .. | Groundnuts |
|          |    | Cotton     |

and so on. The treatments are applied in alternate years commencing with the 1st year. The lay-out is in the form of a Latin Square.

This season the manures were not applied and residual values were tested with crops of groundnuts and cotton. A considerable reduction in the yield of cotton occurred in all treatments, giving indications of a considerable reduction in fertility despite the addition of cotton seed, green-manure or both, in alternate years. The structure of the soil has changed considerably and it has become typical of over cultivated soils.

The yields were as follows:—

| Treatment.                       | Yield of<br>Groundnuts<br>lbs. per acre<br>unshelled. | Yield of<br>Seed-Cotton<br>per acre.<br>(lbs.). |
|----------------------------------|-------------------------------------------------------|-------------------------------------------------|
| Control .. ..                    | 1,130                                                 | 328                                             |
| Cotton seed .. ..                | 964                                                   | 429                                             |
| Green manure .. ..               | 1,110                                                 | 361                                             |
| Cotton seed plus Green-manure .. | 1,060                                                 | 405                                             |

The results are not significant, but, as in the 1934/35 season, they indicate a residual value for cotton seed on the cotton crop.

It is of interest here to give the total crop yields produced by each treatment since the experiment was started in 1933.

| Treatment.                       | Total Yield in Lbs. per Acre. |             |
|----------------------------------|-------------------------------|-------------|
|                                  | Cotton.                       | Groundnuts. |
| Control .. ..                    | 2,764                         | 2,257       |
| Cotton-seed .. ..                | 3,515                         | 2,484       |
| Green-manure .. ..               | 3,033                         | 2,032       |
| Cotton-seed plus Green-manure .. | 3,407                         | 2,287       |

Cotton seed has increased the yield of Groundnuts whereas Green-manure has depressed it. Cotton seed has given a considerable increase in cotton over control but it must be remembered that no less than 11 tons of cotton seed have been applied per acre so that Cotton seed is hardly an economic proposition.

## 2. TOBACCO MANURIAL EXPERIMENT.

Cotton seed, cotton seed ash and kraal manure are used as manures for the tobacco crop in a Cotton—Tobacco rotation, the control being a three year resting period in place of manures.

The rotation is—

|          |                   |                           |
|----------|-------------------|---------------------------|
| 1st year | ..                | Tobacco (Manures applied) |
|          |                   | Cotton.                   |
| 2nd year | ..                | Groundnuts.               |
|          |                   | Cotton.                   |
| 3rd year | as 1st and so on. |                           |
| Layout   | ..                | 4'×4' Latin Square.       |

Groundnuts were followed by cotton this season, no manure being applied as they are only applied to the tobacco crop grown in alternate years.



The following yields were obtained:—

| Treatment.                      | Yield in Lbs. per Acre.    |              |
|---------------------------------|----------------------------|--------------|
|                                 | Groundnuts<br>(unshelled). | Seed-cotton. |
| Control .. ..                   | 1,700                      | 351          |
| Kraal manure .. ..              | 1,850                      | 372          |
| Cotton seed .. ..               | 1,930                      | 364          |
| Cotton seed ash .. ..           | 2,000                      | 464          |
| Least Significant Difference .. | Nil                        | Nil          |

Although the results are not significant they are suggestive, and indicative of the residual value of cotton seed ash. The cotton yields were low owing to late planting after the groundnut crop.

### 3. ELEPHANT GRASS ROTATION EXPERIMENT.

*Object.*—To find out the period under elephant grass fallow necessary to maintain soil fertility. The three periods in this experiment are 2, 3 and 4 years with continuous cropping as a control.

The rotation used is:—

|          |    |                        |
|----------|----|------------------------|
| 1st year | .. | Cotton.                |
| 2nd year | .. | Groundnuts.<br>Cotton. |
| 3rd year | .. | Cotton (interplanted). |
| 4th year | .. | Treatments begin.      |
| Lay-out  | .. | 4' × 4' Latin Square.  |

Groundnuts and cotton were taken off all plots.

The groundnuts averaged 2,100 lbs. per acre (unshelled) and the cotton 690 lbs. per acre (seed cotton). A point of considerable interest is that most of those plots which gave low yields in the previous season gave high yields this season and *vice versa*.

### 4. TOBACCO—COTTON ROTATION EXPERIMENT.

A test of four rotations bringing in tobacco as well as cotton, three of the rotations using elephant grass as a fallow crop and the fourth using green-manure two years in succession. The rotations are:—

| A        |                                   | B                              | C                              | D                         |
|----------|-----------------------------------|--------------------------------|--------------------------------|---------------------------|
| 1st year | .. Tobacco.<br>Cotton.            | Cotton.                        | Tobacco.<br>Cotton.            | Tobacco.<br>Cotton.       |
| 2nd year | .. Groundnuts.<br>Cotton.         | Tobacco.<br>Cotton.            | Groundnuts.<br>Cotton.         | Groundnuts.<br>Cotton.    |
| 3rd year | .. Tobacco.<br>Cotton.            | Groundnuts.<br>Cotton.         | Tobacco.<br>Cotton.            | Green-manure.<br>Cotton.  |
| 4th year | .. Elephant grass<br>for 4 years. | Elephant grass<br>for 3 years. | Elephant grass<br>for 3 years. | as 3rd year and<br>so on. |

Lay-out 4' × 4' Latin Square.

The tobacco plots were divided into equal sub-plots for air cured and fire cured tobacco respectively. The former was almost a complete failure while the yields from the latter were very poor.

### Sweet Potatoes.

The Ridge versus Hill method of planting experiment was repeated with the same varieties—Kawa and Kaungezi. The results were as follows (lbs. per acre):—

|        |       | Kawa. | Kaungezi. |
|--------|-------|-------|-----------|
| Ridges | ..    | 6,344 | 12,022    |
| Hills  | .. .. | 5,658 | 10,704    |

The yields are low and the figures give Kaungezi a significantly higher yield than Kawa with no difference in yield between Ridges and Hills. The difference in varietal yields is probably a false one as under the rotation in use at present it is impossible and impracticable to dig the potatoes in the native fashion, *i.e.*, to remove the tubers with sticks as they ripen. The native criticism of this experiment is that if their method of harvesting were to be adopted the yield of Kawa would be much higher. Some new local varieties were obtained, two of which are reputed to mature 3–4 weeks earlier than the normal varieties. Both of these—Kyai and Sekolya—are undergoing an extensive trial.

### Groundnuts.

The variety trial was limited to a test of Local Bunch, Bukalasa Bunch and Virginia Bunch (Bukalasa). The results provided the necessary confirmation that all three “varieties” are identical. The yields in lbs. per acre of unshelled nuts were:—

|                           |    |    |            |
|---------------------------|----|----|------------|
| Virginia Bunch (Bukalasa) | .. | .. | 3,010 lbs. |
| Local Bunch               | .. | .. | 3,000 „    |
| Bukalasa Bunch            | .. | .. | 2,910 „    |

There was no significance.

The high yields are particularly noteworthy, the crop being the first after the three year elephant grass fallow.

### Robusta Coffee.

#### (1) SHADE AND COVER CROP EXPERIMENT.

The yields for 1936/37 season were as follows:—

*Yields in Lbs. Fresh Cherry per Acre.*

|                 |       | No shade. | Banana shade. | <i>Glyricidia</i> shade. | Mean.   |
|-----------------|-------|-----------|---------------|--------------------------|---------|
| Clean weeded    | ..    | 6,395     | 5,388         | 5,204                    | 5,661·3 |
| Permanent cover | ..    | 6,295     | 5,052         | 5,138                    | 5,495·7 |
| MEAN            | .. .. | 6,345     | 5,220         | 5,171                    | 5,578·7 |

The results are significant when  $P=0\cdot01$  and the least significant difference is 658. There was no difference in yield between clean weeding and permanent cover irrespective of shade or no shade; while no shade gave a better yield than either banana or *glyricidia* shade. Both no shade treatments yielded better than the other treatments. The crop is the second largest

harvested, the annual totals of wet cherry being:—

|         |    |                |                      |
|---------|----|----------------|----------------------|
| 1932/33 | .. | 19,620 lbs. or | 3,820 lbs. per acre. |
| 1933/34 | .. | 41,139   "   " | 8,000   "   "   "    |
| 1934/35 | .. | 23,031   "   " | 4,500   "   "   "    |
| 1935/36 | .. | 28,483   "   " | 5,550   "   "   "    |
| 1936/37 | .. | 33,472   "   " | 6,500   "   "   "    |

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TOTAL   .. 145,746 lbs. or 28,370 lbs. per acre.

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This is equivalent to 12½ tons of fresh cherry per acre in five seasons.

## (2) GROUND TREATMENT EXPERIMENT.

The mulched plots remained outstanding in appearance throughout the season. It was particularly noticeable that in dry weather the amount of leaf shedding was very much less in the mulched plots than in the clean weeded and weed cover plots.

The yields to-date are as follows:—

### *Yields in Lbs. Fresh Cherry per Acre.*

| Treatments.                  |    |    | 1936/37<br>season. | Grand Total<br>to-date. |
|------------------------------|----|----|--------------------|-------------------------|
| Clean weeding                | .. | .. | 9,177·0            | 25,168·6                |
| Mulched                      | .. | .. | 12,874·5           | 29,095·0                |
| Cover crop                   | .. | .. | 9,027·5            | 14,568·2                |
| Weed cover                   | .. | .. | 7,698·1            | 10,931·9                |
| Least Significant Difference |    |    | 2,861              | ..                      |

The increase over the other three varieties due to mulching is significant while there are no differences between the other three treatments.

## (3) SHADE AND GROUND TREATMENT No. 2.

### *Robusta Coffee.*

Treatments:

Shade and No Shade.

Mulch.

Alternate Row Mulch.

October–March Cover crop.

Clean weeding.

Cotton seed (one petrol tin per tree per year).

No cotton seed.

Eight varieties—One row of each per plot.

Lay-out.—Random blocks.

The first crop was harvested from this experiment during the season but the only treatments which have been applied so far are shade and cotton seed. Mulching commenced early in 1937 and the first cover crop will be planted in October, 1937.

The effect of the annual applications of cotton seed to half of each plot is pronounced, and the yields were considerably more than those of the untreated plots.

The total yields to-date are as follows:—

|             |    |    |       |                    |
|-------------|----|----|-------|--------------------|
| Cotton seed | .. | .. | 4,000 | lbs. fresh cherry. |
| Control     | .. | .. | 2,363 | "   "   "          |
| Shade       | .. | .. | 2,919 | "   "   "          |
| No shade    | .. | .. | 3,449 | "   "   "          |

## (4) SHADE DEMONSTRATION PLOTS.

The Nganda trees have made very slow progress on all plots and the shade trees have been difficult to establish. A preliminary test of using sunflowers for mulching indicated that the crop might have possibilities for providing mulch material in areas where elephant grass is not available.

## (5) COFFEE DRYING FLOOR.

In view of the propaganda towards cleaner coffee, carried on in Buganda by the Department, it was decided to lay down a cement drying floor at Bukalasa for demonstration purposes. Many of these floors have already been laid down in Bulemezi and parts of Entebbe District but little information is available with regard to costs, capacity, etc. The floor at Bukalasa was laid down with two mixtures of cement—6 of sand to 1 of cement and 4 to 1—in order to obtain information as to the length of time the floor will last with cheap mixtures. The floor dimensions were 28' × 28' with a store attached. The cost of the floor was Shs. 79, the weak mixture costing Shs. 34 and the other half Shs. 45. The store consists of mud and wattle, roofed with old corrugated iron, a cement floor, and cement washed walls; and the cost was Shs. 34. The full capacity of the floor at any one time is approximately 2,000 lbs. of fresh cherry, taking approximately seven days to dry; so that a floor of this size is capable of dealing with 8,000 lbs. of fresh cherry a month. It is difficult to assess what area this floor can deal with but a rough estimate suggests that it could deal with an average crop from at least four acres. An area of 200 square feet is thus required for an acre of coffee at 10' × 10' spacing.

## Model Shamba.

The same tenant was in occupation throughout the season. Yields in general were poor and disappointing, and the lusuku shows obvious signs of failing.

The following yields per acre were obtained from the economic plots:—

|            |    |    |    |          |
|------------|----|----|----|----------|
| Maize      | .. | .. | .. | 740 lbs. |
| Sim-sim    | .. | .. | .. | 48 "     |
| Groundnuts | .. | .. | .. | 1,616 "  |
| Cotton     | .. | .. | .. | 306 "    |

In addition 171 lbs. of sun-dried cherry were harvested from the coffee plot which consists of 181 trees.

| <i>Summary of Income.</i> |    |    |            |           | <i>Shs. cts.</i> |       |
|---------------------------|----|----|------------|-----------|------------------|-------|
| Cotton safi               | .. | .. | 381 lbs. @ | 13/50     | ..               | 51 43 |
| " "                       | .. | .. | 112 "      | @ 14/-    | ..               | 15 68 |
| " "                       | .. | .. | 68 "       | @ 16/-    | ..               | 10 88 |
| " 'fifi'                  | .. | .. | 50 "       | @ 4/-     | ..               | 2 00  |
| Maize ..                  | .. | .. | 370 "      | @ 1 cent  | ..               | 3 70  |
| Groundnuts                | .. | .. | 758 "      | @ 6 cents | ..               | 45 48 |
| Sim-sim                   | .. | .. | 24 "       | @ 6 "     | ..               | 1 44  |
| Coffee ..                 | .. | .. | 127 "      | @ 10 "    | ..               | 12 70 |
| " ..                      | .. | .. | 44 "       | @ 9 "     | ..               | 3 96  |

|                                                              |      |       |        |
|--------------------------------------------------------------|------|-------|--------|
| <i>Gross income</i>                                          | ..   | Shs.  | 147 27 |
| <i>Deduct 118 man-days labour employed (at 1/33 per day)</i> | Shs. | 38 94 |        |

NET PROFIT .. Shs. 108 33



The continual failure of the sim-sim crop points to the fact that this particular site is unsuited to sim-sim. In future sim-sim will be omitted from the rotation and early sown cotton will be planted in its place.

The extra labour used this season was necessary to mulch the coffee plot.

### Other Crops.

Considerable quantities of *Soy Beans* and *Tepary Beans* were grown and seed distributed to neighbouring cultivators. All varieties of *Beans* have been maintained.

The *Tung Oil* trees have made no progress and several have died out completely.

The plot of *Tea* grown for seed production has been most unsatisfactory and less than a dozen trees remain.

A half-acre plot planted with *Tara Beans* was a complete failure, only three seeds germinating.

### Elephant Grass.

Investigations into methods of planting elephant grass and its subsequent development were carried on. Makerere students were given this as a study and the work they did was satisfactory and encouraging.

N. S. HAIG, *Senior Agricultural Officer.*

G. W. NYE, *Senior Botanist.*

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# ANNUAL REPORT ON EXPERIMENTAL WORK IN THE EASTERN PROVINCE, 1936.

By THE SENIOR AGRICULTURAL OFFICER, JINJA.

## Section 1.—Groundnuts.

### 1. VARIETY, MULCHING AND WEEDING TRIAL.

(a) *Object*.—Continuation of last year's experiment to observe the effect of ground cover on yield and incidence of Rosette disease, with Bunch and Spreading varieties. At Serere.

#### (b) *Treatments*.—

Varieties, Bunch and Spreading.

Cultural Treatments, Grass mulch.

Clean weeded.

No weeding for 3 weeks.

No weeding for 6 weeks.

(c) *Results*.—No significant difference between ground treatments was found. Stand was good, and incidence of Rosette negligible. Therefore conditions calculated to cause a differential effect between treatments were absent. In view of this no figures are published, but they are filed for future combined analysis with other seasons and Provinces.

### 2. COTTON INTERPLANTED WITH GROUNDNUTS.

(a) *Object*.—Observation plots last year indicated that there was an increased cash return from interplanting these two cash crops, as compared with cotton alone. This was followed up by a more elaborate experiment as follows.—

#### (b) *Treatments*.—

Bunch Groundnuts alone.

Cotton alone.

Cotton and 1 row Groundnuts.

Cotton and 2 rows Groundnuts.

#### (c) *Lay-out*.—Five blocks of four randomised plots.

Plots 27' × 27'.

Spacing of Cotton 3' × 1'.

Spacing of Groundnuts 9" × 9".

#### (d) *Centres*.—Katakwi, Toroma and Kumi.

#### (e) *Results*.—

*Yields in Lbs. Unshelled Nuts per Acre.*

| Centre.                                          | Groundnuts<br>alone. | Cotton<br>alone. | Cotton and 1 row<br>Groundnuts,<br>Cotton. Groundnuts. | Cotton and 2 rows<br>Groundnuts.<br>Cotton. Groundnuts. |
|--------------------------------------------------|----------------------|------------------|--------------------------------------------------------|---------------------------------------------------------|
| Katakwi ..                                       | 14                   | 591              | 622 .. 63                                              | 477 .. 34                                               |
| Toroma ..                                        | 59                   | 529              | 570 .. 0                                               | 456 .. 5                                                |
| Kumi ..                                          | 69                   | 539              | 539 .. -9                                              | 456 .. -17                                              |
| All centres ..                                   | 47                   | 553              | 577 .. 18                                              | 463 .. 7                                                |
| Total cash return,<br>all centres ..             | Shs. 2/35            | Shs. 66/36       | Shs. 70/14                                             | Shs. 55/91                                              |
| Groundnuts<br>weighted for<br>stand, all centres | 47                   | ..               | .. 72                                                  | .. 28                                                   |

The estimated weight of groundnuts used for sowing has been deducted in each case.

(f) *Conclusions*.—Two rows of groundnuts depressed the yield of cotton; one row did not do so. Weighting the groundnuts for stand (*i.e.*, number of rows planted) the single interplanted rows yielded above expectation; double rows yielded below expectation. All groundnuts yielded poorly owing to Rosette disease.

The cash return is based on a price of 12 cents per lb. for cotton and 5 cents per lb. of unshelled groundnuts, which were the approximate ruling prices for the season.

Cotton and one row of groundnuts show a slight cash advantage over cotton alone.

## Section 2.—Cotton.

(a) *SPACING AND SOWING DATE TRIAL*.—It is considered that close spacing and early sowing have been proved to be the best over the greater part of the Province, but further information was desired regarding the special area of Samia in Budama District.

Owing to unavoidable delay, the requisite number of replications could not be planted, and statistically the results were not significant. The first order figures are given, however, as they are of interest.

### (b) *Results*.—

| Sowing date.   | Yield per acre. | Spacing. | Yield per acre. |
|----------------|-----------------|----------|-----------------|
| July 17th      | .. 763 lbs.     | 3' × 1'  | .. 794 lbs.     |
| August 7th     | .. 499 lbs.     | 3' × 1½' | .. 1,028 lbs.   |
| August 28th    | .. 527 lbs.     | 3' × 2'  | .. 618 lbs.     |
| September 18th | .. 292 lbs.     |          |                 |
| October 9th    | .. 365 lbs.     |          |                 |

The figures indicate that 3' × 2' spacing is probably worse than the two closer spacings, and that the earliest planting is the best.

An account of other cotton experiments is given in the Botanist's report.

## Section 3.—Coffee.

### BUGUSEGE EXPERIMENTS.

The results for the year under review are given, together with the total yield to date of each treatment. The annual yields of each treatment, object of experiments, and details of layout were given in *Annual Report, Part II*, for 1935.

#### 1. 1927 Planted Pruning Experiment.

(a) *Result*.—Aggregate yields in lbs. cherry per treatment for the 7 seasons 1929/1936 together with the present season's yields.

|                |    | Single stem. | Multiple stem. | Agobiada. |
|----------------|----|--------------|----------------|-----------|
| Previous total | .. | 15,213       | 22,993         | 31,968    |
| 1936-37        | .. | 3,068        | 3,102          | 2,754     |
| Total to date  | .. | 18,281       | 26,095         | 34,722    |

(b) *Conclusions*.—During the present season there were no significant differences between treatments. The previous conclusions still apply and over the eight seasons Agobiada is better than Multiple stem, which in turn is better than Single stem. Agobiada has not produced so bold a bean during

the last three seasons. The "die back" and heavy mortality among single stem trees show that this system is not suited to Bugusege conditions. The differences between seasons are very significant, and biennial fluctuation is most marked in the Single stem and least so in the Multiple stem treatment.

## 2. Pruning Experiment, 1930.

(a) *Results*.—Aggregate yields in lbs. of cherry per treatment for the 4 seasons 1932/3 to 1935/6 inclusive, together with the present season's yields.

|                |    | Natural Growth. | Agobiada. | Modified<br>multiple stem. |
|----------------|----|-----------------|-----------|----------------------------|
| Previous total | .. | 3,451           | 2,324     | 5,557                      |
| 1936-37        | .. | 76              | 244       | 394                        |
| Total to date  | .. | 3,527           | 2,568     | 5,951                      |

(d) *Conclusions*.—Modified multiple stem has been consistently superior to the other two treatments since full bearing commenced. Over the five seasons natural growth is better than Agobiada, but these positions were reversed in 1936-37, when natural growth was practically a failure.

## 3. Cultural Experiment, 1928.

Owing to the unsatisfactory state of the trees, which were pruned on the single stem system up to 1930, after which they were allowed unlimited terminal growth, the experiment was stumped in January, 1936, and there are therefore no yields to record this year.

## 4. Cultural Experiment, 1932.

(a) *Results*.—Aggregate yields in lbs. cherry per treatment for the two seasons 1934/1936 together with present season's yields.

|                |    | Clean<br>weeded. | 2 cover<br>crops. | Mulch. | Weed<br>cover. | October-<br>March<br>cover. | March-<br>October<br>cover. | Shade. |
|----------------|----|------------------|-------------------|--------|----------------|-----------------------------|-----------------------------|--------|
| Previous total | .. | 856              | 341               | 1,382  | 143            | 904                         | 1,705                       | 663    |
| 1936-37        | .. | 250              | 415               | 783    | 249            | 865                         | 467                         | 585    |
| Total to date  | .. | 1,106            | 756               | 2,165  | 392            | 1,769                       | 2,172                       | 1,248  |

(b) *Conclusions*.—March-October cover crop still shares supremacy with banana leaf mulch, though it has dropped in the present season. It appears that the previous treatment of banana stem and leaf mulch is now losing its effect. October-March cover crop comes up in the third year and is now equal to the above mentioned treatments. Clean weeded drops badly in the third year, and now occupies fourth place. Weed cover is again the worst of all. Erosion is becoming serious on the clean weeded and October-March cover plots



### 5. Spacing and Pruning Experiment, 1932.

(a) *Results*.—Aggregate yields of cherry per treatment for the two seasons 1934/1936, together with present season's yields.

| Pruning.                  | Season.           | 8'×8'. | 7'×7'. | 6'×6'. | 4'×4'. | Totals. |
|---------------------------|-------------------|--------|--------|--------|--------|---------|
| Natural Growth ..         | Previous total    | 1,632  | 1,880  | 2,562  | 4,408  | 10,482  |
|                           | 1936/7 ..         | 313    | 195    | 341    | 737    | 1,586   |
|                           | Total ..          | 1,945  | 2,075  | 2,903  | 5,145  | 12,068  |
| Modified multiple stem .. | Previous total .. | 1,350  | 1,863  | 2,451  | 2,662  | 8,326   |
|                           | 1936/7 ..         | 679    | 767    | 1,024  | 1,628  | 4,098   |
|                           | Totals ..         | 2,029  | 2,630  | 3,475  | 4,290  | 12,424  |

(b) *Conclusions*.—The following conclusions are statistically significant. To begin with natural growth was superior, but in the third cropping season modified multiple stem was much better, and on the combined seasons the two systems are now equal. The closest spacing is still the best, and this year there is no difference between the three wider spacings. For all seasons, natural growth has responded better than modified multiple stem to the 4'×4' spacing.

### 6. Shade Experiment, 1932.

At the end of 1935, the whole experiment was stumped, owing to the etiolation of the shaded coffee. In place of the Modified multiple stem treatment the trees have been converted to single stem, and are "capped" to maintain sturdy growth and induce secondary growth. There are therefore no yields to record in the season under review.

### 7. New Experiments.

The following were laid down in 1936.

Supplementary to the 1932 cultural trial, an experiment was started to investigate further the effect of altering the carbohydrate/nitrogen ratio by various methods of green manuring and to ascertain whether the harvesting of cover crops is detrimental.

Treatments:—

- (a) September–February cover, clean weeded remainder of year.
- (b) October–March cover, clean weeded remainder of year.
- (c) November–April cover, clean weeded remainder of year.
- (d) October–December cover, dug in green and clean weeded remainder of year.

(e) October–December cover dug in green and mulched over the dry season with banana leaves.

(f) Biennial Fluctuation treatment (*i.e.*, March to October cover in poor cropping years to decrease yield in following season, followed by October–March cover to increase yields in theoretically poor cropping year).

A close spacing, stumping and uprooting experiment was also laid down to investigate the advisability of rotational stumping of closely planted coffee.

Treatments:—

|            |                                         |
|------------|-----------------------------------------|
| 3' × 3'    | Spacing, uprooting of alternate lines.  |
| 4' × 3' 9" | " " "                                   |
| 5' × 5'    | " " "                                   |
| 3' × 3'    | " stumping in rotation alternate lines. |
| 4' × 3' 9" | " " "                                   |
| 5' × 5'    | " " "                                   |

A further replicated experiment was planted at Bududa in Bugishu to test a number of varieties of coffee for susceptibility to "die-back".

|           |                            |
|-----------|----------------------------|
| Varieties | Bugishu Local.             |
|           | Harar.                     |
|           | Blue Mountain.             |
|           | Kenya Selected Series "A". |
|           | Kent's Arabica.            |

### 8. Other Coffee Experiments.

1. *A Shade Experiment* (unreplicated) at Bubulu, Bugishu, has given the following results:—

| Treatment.                         | Total Yield in Lbs. Cherry<br>1934/5 to 1936/7. |
|------------------------------------|-------------------------------------------------|
| Unshaded unlimited terminal growth | .. 3,347                                        |
| Shaded " " "                       | .. 3,505                                        |
| Unshaded Single stem .. ..         | .. 2,151                                        |
| Shaded " " .. ..                   | .. 2,120                                        |

*Conclusions.*—Single stem has given a definitely poorer yield, which coincides with conclusions elsewhere in the District and this treatment is now discontinued. Shade has had little effect, and the experiment is to be stumped and the effect of shade on another system of pruning will be tried.

2. *A Cultivation Experiment* (unreplicated) has given the following results at Bubulu:—

| Treatment.                           | Total Yield in Lbs. Cherry<br>1935/1937. |
|--------------------------------------|------------------------------------------|
| Mulched and dug in December only     | .. 3,739                                 |
| Mulched and dug in December and June | .. 3,113                                 |

Digging in June appears to depress the yield.

3. *Cover Crop Experiment.*—An extension at Bubulu of the Bugusege experiment. Yields in lbs. cherry are as follows:—

| Treatment.               | 1935/6.  | 1936/7.  | Total.   |
|--------------------------|----------|----------|----------|
| October–March Cover crop | .. 660   | .. 1,912 | .. 2,572 |
| March–October Cover crop | .. 1,123 | .. 1,642 | .. 2,765 |

In the 1935/6 season the October to March cover crop gave an abnormally low yield. This year's results are in accordance with those of Bugusege.

Another plot is under observation for the effect of farm yard manure on liquoring quality.

4. *Robusta Coffee.*—The experiments detailed in last year's report are just into bearing and there are no results to record.

## Section 4.—Other Crops.

## A. TOBACCO.

Trial plots of air and fire cured types were laid down at three centres in Samia, Budama District, in the Spring and Autumn rains. Both crops suffered from unfavourable weather conditions at planting time. Air cured leaf of quite good colour was produced at two centres, but the fire cured types were a failure.

## B. CASSAVA.

1. *Cassava Variety Trials.*

(a) *Object.*—To find a variety of cassava suitable as a famine reserve that yields well, is resistant or partly resistant to Mosaic disease, and that is palatable.

(b) *Results.*—The following is the combined analysis of the three experiments in Teso District.

*Yield in Lbs. Fresh Weight per Acre.*

| Variety.                     | Centre and Season. |                  |               | Combined |
|------------------------------|--------------------|------------------|---------------|----------|
|                              | Serere 1934/35.    | Katakwe 1935/36. | Kumi 1935/36. |          |
| Bobby Hanson .. ..           | 30,185             | 47,643           | 35,273        | 37,702   |
| Smalling .. ..               | 25,428             | 39,493           | 29,726        | 31,550   |
| Brownstick .. ..             | 22,512             | 34,218           | 15,144        | 23,959   |
| Mugowa .. ..                 | 12,721             | 40,480           | 15,892        | 23,032   |
| Bunch of Keys .. ..          | 18,200             | 28,926           | 18,547        | 21,892   |
| Nyumb'ezunga .. ..           | 14,647             | 25,625           | 15,484        | 18,586   |
| Numbu .. ..                  | 10,158             | 16,573           | 10,226        | 12,320   |
| Nodewide .. ..               | 8,446              | 16,743           | 8,287         | 11,159   |
| Teso .. ..                   | 6,323              | 15,042           | 9,716         | 10,360   |
| Least Significant Difference | 5,373              | 15,275           | 9,011         | 5,985    |

*Conclusions.*—The results are highly dependable and apply to wide areas in Teso. Mugowa being a bad setter is more variable than the rest. Bobby Hanson is the best yielder followed closely by Smalling. The first five varieties are bitter, and the last two are sweet. Tests for palatability and keeping qualities are now being done, when increase of the most suitable will be commenced.

2. *Cassava Mosaic Experiments.*

*Object.*—To ascertain the reduction in yield by planting mosaic infected cuttings.

*Layout.*—Six rows of 20 diseased cuttings of local Teso variety interplanted with similar rows of healthy material. These were planted at the same centres and times as the Variety Trials.

*Results. Average Yield in Lbs. per Plant.*

| Centre.       |    | Diseased. | Healthy.  |
|---------------|----|-----------|-----------|
| Serere .. ..  | .. | 2.2 lbs.  | 4.9 lbs.  |
| Katakwi .. .. | .. | 3.6 lbs.  | 11.6 lbs. |
| Kumi .. ..    | .. | 5.6 lbs.  | 15.0 lbs. |

*Conclusions.*—The Serere plants were harvested after 12 months and the others after 22 months which explains the lower yield of the former experiment.



The figures are highly significant, and illustrate the value of this line of attack in promoting better yields.

### Section 5.—Fertility Experiments.

#### A. MANURIAL EXPERIMENT.

(a) *Object*.—To compare the effect of varying amounts of farmyard manure and green manure with lime as a measure for retention of soil fertility. At Serere.

(b) *Layout*.—This experiment has been running since 1933, and details of treatments and layout are contained in last year's report.

(c) *Results*.—The yields of the first cotton crop in the second cycle of the experiment are as follows:—

| Treatment.                                | Lbs. per acre. |
|-------------------------------------------|----------------|
| Green manure, <i>Crotalaria juncea</i> .. | 560            |
| „ „ and Lime ..                           | 574            |
| Farmyard manure, 10 tons per acre ..      | 755            |
| „ „ 20 tons per acre ..                   | 746            |
| „ „ 30 tons per acre ..                   | 798            |

(d) *Conclusions*.—The three farmyard manure treatments are significantly superior to the two green manure treatments.

#### B. REGENERATION OF OLD LAND.

*Object*.—To compare the regenerative qualities of five grasses, planted or sown, against natural weed cover.

*Varieties*.—*Chloris Gayana*. *Hyparrhenia dissoluta*. *Cynodon plectostachyum*. *Imperata cylindrica*. Natural weed cover. *Pennisetum purpureum*.

*Layout*.—One-twelfth-acre plots of each grass in four randomised blocks, each pair of blocks being left for a 3- and 5-year period respectively. An index crop of cotton was grown in 1936.

*Results*.—The grasses were planted in Spring 1937. The first three have made a good cover but the *Hyparrhenia* has failed and has been replaced by *Cajanus indicus*.

#### C. COMPREHENSIVE FERTILITY EXPERIMENT.

This is a replicated experiment of 450 plots at Serere to test five types of resting period ground cover with three periods of resting and two manurial treatments together with no manure. The experiment has completed its first year.

A full account of the layout appeared in the *East African Agricultural Journal* for March, 1937, together with a description of an associated experiment to test various types of anti-erosion measures.

T. R. HAYES,

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